THESIS

A REVISION OF THE GENUS *PACHYRHINUS* SCHOENHERR 1823 (COLEOPTERA: CURCULIONIDAE) IN THE NEARCTIC REGION

Submitted by

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ABSTRACT

A REVISION OF THE GENUS *PACHYRHINUS* SCHOENHERR 1823 (COLEOPTERA: CURCULIONIDAE) IN THE NEARCTIC REGION

This paper presents a revision of the North American species of the broad nosed weevil genus *Pachyrhinus* (Coleoptera: Curculionidae) Schönherr, 1823, which includes eight currently recognized species. *Pachyrhinus* is considered a minor pest of *Pinus* spp. Three species of *Pachyrhinus* are now recognized in North America: *P. elegans* (Couper, 1865), *P. californicus* (Horn, 1876), and *P. cinereus* (Casey, 1888). *Pachyrhinus lateralis* (Casey, 1888) and *P. miscix* (Fall, 1901) are considered synonyms of *P. elegans*. *Pachyrhinus crassicornis* (Casey, 1888) and *P. albidus* (Fall, 1901) are synonyms of *P. cinereus*. The previous synonymy of *P. ferrugineus* (Casey, 1888) with *P. californicus* was confirmed. The revision includes detailed images of diagnostic characters as well as scanning electron micrographs of scale morphology for all species.

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Introduction

The Entiminae, commonly known as broad nosed weevils, is the largest subfamily of Curculionidae in North America (Anderson 2002). Members of the subfamily are recognized by a short, broad, subquadrate rostrum and, in most species, by a deciduous process on the mandible that breaks off soon after adult emergence leaving behind a distinctive scar (Anderson 2002). The group contains many economically important species (Furniss and Carolin 1977) and several genera are in need of revision (Anderson 2002). One such genus is *Pachyrhinus* Schönherr, 1823, in the tribe Polydrusini (O'Brien 1982). Polydrusini is primarily Palearctic and includes the genera *Apodrusus* Marshall 1922, *Auchmeresthes* Kraatz 1862, *Bremondiscytropus* Hoffman 1942, *Gobidrusus* Korotaev 1979, *Homapterus* Fairmaire 1857, *Liophloeus* Germar 1817, *Metadrosus* Skilsky 1910, *Polydrusus* Germar 1817, *Sitonapterus* Reitter 1913, and *Synaptorhinus* Faust 1889 (Girón and Franz 1922, Gösik et al 2010).

Pachyrhinus was first proposed by Schönherr (1823) in which he designated *Curculio mustela* Herbst, 1797 as the type species, no description was included and the name was considered a *nomen nudum*. Schönherr (1826) also listed *C. mustela* as the type species for the newly proposed genus *Scythropus*, this time including a diagnosis. Another synonym for *Pachyrhinus*, *Carpomanes*, was proposed by Gistel (1856) with *C. mustela* once again designated as the type species. However, *Carpomanes* was generally ignored by researchers and *Scythropus* continued to be used. *Carpomanes* was synonymized with *Pachyrhinus* by Alonzo-Zarazaga (1999) and *Pachyrhinus* was resurrected from *nomen nudum* status by O'Brien (1982) with *Scythropus* as a junior synonym; the species then placed in *Scythropus* were transferred to

Pachyrhinus. Before *Pachyrhinus* was resurrected, *Scythropus* was the most commonly used name for the species within the genus. Some publications, particularly those from Japan and eastern Russia, continue to refer to some species currently in the genus *Polydrusus* Germar, 1871 as *Scythropus* (Lafer 1999, Huang and Lee 1993).

Members of *Pachyrhinus* are distinguished by a prominent glabrous callosity above the epistoma and by a dense covering of elongate scales (Anderson 2002). Other important traits include a long scape that extends beyond the eye, a closed corbel, connate tarsal claws, prominent elytral humeri, and red legs covered in white setae. Elytral scales range in color from emerald green and rust orange to ash grey (Horn 1876). They range between 5-10 mm long (Anderson 2002).

Pachyrhinus includes 35 species (Gösik et al 2010), ranging across the temperate Holarctic Region (Alonzo-Zarazaga and Lyal 1999). Most of these species are Palearctic in distribution with the greatest species diversity occurring in northern Africa (Gösik et al 2010). Seven of these species are Nearctic (O'Brien 1982; Bright and Bouchard 2008). Among the Nearctic species, only one, *P. elegans* (Couper, 1865), occurs outside western North America. The genus is associated with the genera *Pinus* and *Pseudotsuga* (Furniss and Carolin 1977). The larvae feed on the roots, whereas the adults feed on the needles (Jensen and Koehler 1969). Since species of *Pinus* are economically important in lumber production and as ornamentals. *Pachyrhinus* species are considered minor pests (Furniss and Carolin 1977). They also tend to occur in large numbers. In Oregon stands of Douglas fir (*Pseudotsuga menziesii*), *Pachyrhinus* was found to compose 4.6% of the phytophagous arthropod population (Mispagel and Rose 1978). Some *Pachyrhinus* have exhibited dramatic expansions in their range. In particular, *P. elegans* has recently been discovered in New Brunswick, Canada (Majka et al 2007) and, in the

Palearctic, *P. lethierryi* (Desbrochers 1875) has expanded from its home range in Corsica, Sardinia and southern France into the Netherlands and England (Gösik et al 2010).

The first Nearctic species of *Pachyrhinus* to be described was *P. elegans* (Couper 1865a). This species is the most common and widely distributed member of the genus in North America with a range extending from Nova Scotia and British Columbia south to California and Pennsylvania (Arnett 1996). The second species to be described was *P. californicus* (Horn 1876), which is common as well but its range is restricted to the Pacific states and British Columbia. Four more species of *Pachyrhinus* were described by Casey (1888) and one by Horn (1894). These new descriptions prompted Fall to review the genus (1901) review the genus and add two additional species. Fall also concluded that *S. delicatulus* (Horn 1894) was not a member of *Scythropus* (Fall 1901). It was later placed in the genus *Polydrusus* by Pierce (1901). Fall's review, while useful in providing the only available key for Nearctic *Pachyrhinus* at the time, was incomplete. He was unable to examine Casey's types and therefore relied solely on the written species concepts proposed in Casey (1888). As a result, Fall (1901) simply restated the descriptions found in Casey (1888) and did not evaluate any of the species Casey described. All eight species were reviewed again by Jensen (1963) who made no taxonomic change except for defining, but not naming, two additional species. Jensen's manuscript was never published. Most recently, Bright and Bouchard (2008) reviewed the three species of *Pachyrhinus* occurring in Canada. After examining types, they concluded that *P. ferrugineu*s was a synonym of *P. californicus.* Here, I provide a review of Nearctic *Pachyrhinus* to redefine the species concepts in to better correspond with the morphological variation found among the species in the genus.

Materials and Methods

More than 1,750 adult specimens and 45 genitalia preparations were examined. The following abbreviations are used for institutional and private collections:

CUIC = Cornell University Insect Collection, Cornell University, Ithaca, New York, USA

CSUC = C. P. Gillette Museum of Arthropod Biodiversity, Colorado State University, Fort Collins, Colorado, USA

CWOB = Charles W. O'Brien, Green Valley, Arizona, USA

EMEC = Essig Museum of Entomology, University of California, Berkeley, California, USA

MCZC = Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts, USA,

UCRC = Entomology Research Museum, University of California, Riverside, California, USA

USNM = United States National Museum, Washington D. C., USA

Specimens were examined and dissected using a Wild M3 stereomicroscope (Wild Heerbrugg AG, Switzerland). Adult photographs were taken using a Canon EOS 7D digital SLR (Canon U.S.A., Melville, New York) mounted on a Visionary Digital BK Lab System (Dun, Inc., Palmyra, Virginia). Microscope slide photos were taken using a Nikon DS-Fi1 Digital Sight microscope camera (Nikon Instruments, Melville, NY) mounted on a SZ/Olympus compound microscope (Tokyo, Japan). Most photographs are a combination of several layers produced with Zerene Stacker (Zerene Systems, Richland, WA). SEM photographs were taken with a JOEL JSM 6500F scanning electron microscope (JOEL ltd, Musashino, Akishima, Tokyo, Japan). All photographs were edited using Adobe Photoshop CS6 Extended (Adobe Systems Inc., San Jose,

CA). Morphological terms and descriptions follow that of Jansen and Franz (2015). Specimens of the following Palearctic species of *Pachyrhinus* were examined in addition to Nearctic material: *P. cedri* (Chevrolat 1866), *P. glabratus* (Chevrolat 1866), *P. grandiceps* (Desbrochers 1894), *P. lethierryi* (Desbrochers 1875), *P. squamulosus* (Herbst 1795), and *P. warioni* (Marseul 1876).

DNA extraction was performed using a Qiagen DNeasy Blood and Tissue kit (Qiagen, Valencia, CA). Entire beetles were crushed, incubated overnight at 56°C, and eluted in 100 µl of AE buffer after following the manufacturer's recommended protocol. Reactions were performed with TaKaRa Ex Taq HS polymerase (Takara Bio, Shiga, Japan) in total volumes of 50 µl using the manufacturer's recommended volumes of 10X Ex Taq buffer and dNTP mixture. The primers TL-J-3037 (5′-TAATATGGCAGATTAGTGCATTGGA-3′) and TK-N-3785 (5′-GAGACCATTACTTGCTTTCAGTCATCT-3′) (Machado et al 2008) were used to amplify a 598 bp segment of cytochrome c oxidase II (COII) using conventional PCR on a Bio-Rad C1000 Touch (Bio-Rad Laboratories, Inc., Hercules, Calif.). PCR conditions included an initial denaturation step of 94°C (3min), 32 cycles of 94°C (20 sec)/ 50°C (20 sec)/ 72°C (30 sec), and an extension step of 72°C (5 min). Amplicons were purified using a Qiaquick PCR Purification Kit (Qiagen, Valencia, CA) and eluted into 35 µl of EB buffer. The purified PCR product was sequenced by the University of Chicago Cancer Research Center DNA Sequencing Facility using an Applied Biosystems 3730XL DNA sequencer (Applied Biosystems, Foster City, California). Individual contigs were assembled using Geneious Pro 5.3.4 (Biomatters Ltd., Auckland, New Zealand). Sequences were aligned in Geneious using ClustalW (Thompson *et al* 1994). PAUP* 4.0b10 (Swofford 2002) was used to construct a neighbor-joining distance tree (Kimura 2-parameter) from the final alignment.

Generic Description of *Pachyrhinus*

Pachyrhinus Schönherr 1823: 40.

= *Scythropus* Schönherr 1826, O'Brien 1982.

= *Carpomanes* Gistel 1856, Alonzo-Zarazaga 1999.

Type species

Pachyrhinus squamulosus, = *Curculio squamulosus* Herbst 1795.

Diagnosis.

Members of *Pachyrhinus* are medium sized (4–10 mm) Holarctic entimine weevils without post ocular lobes or vibrissae, and with elytra bearing well developed humeri (Figure 1). The genus belongs to the Polydrusini, sharing with *Polydrusus* laterally oriented antennae (Figure 2) and connate tarsal claws (Figure 3). It can be distinguished from *Polydrusus* by its thick blunt rostrum bearing a large glabrous callosity and carina on the epistoma (Figures 4 and 5) and by its elongate, scales with only thin poorly developed ribs (Figures 6–8) as opposed to the large pronounced ribs of *Polydrusus* (Figure 9).

Description (male).

Length: 4.0–8.0 mm average 6.5 mm (Figure 1), 2.0X as long as wide in dorsal view, widest portion at midpoint of ⅔ of elytra; shape elongate, subrectangular; dorsal outline in lateral view subplane to weakly convex; color black, red or orange, lighter on legs, antennae red to orange; vestiture composed of elongate, appraised, contiguate, mostly nonoverlapping scales and

both short, recurved and long, erect setae sparsely arranged throughout body, scales 2.0 to 4.0X (Figures 6–9) long as wide, ribbed with ribs extending out into spines on terminal end of scale, variably colored (Figures 10–15), color iridescent green or blue (Figure 10) to orange brown (Figure 11) or ash white (Figure 12), scales lighter to pearlescent on underside, sides and elytral sculus. Head in dorsal view rounded (Figure 4); eyes small, rounded, produced ⅔ from bottom of head, projected outward, in lateral view round (Figure 2), ⅓ length of head in lateral view, separated from anterior margin of prothorax by diameter of eye; ocular sclerites uniformly well defined; frons subrectangular (Figure 4), shortest distance located between eyes, ¾ greatest width of pronotum, bearing shallow impression at apical point where it meets rostrum; ventral surface scaled, bearing sparse pearlescent setae; gular suture clearly visible, rostrum *s*tout (Figure 4), subquadrate, subequal to size of head, in dorsal view ¾ length of head, as long as wide; sides parallel to slightly diverging; medial region slightly impressed; epistomal area, large, nearly semicircular, bearing prominent glabrous carina on edge, separated from nasal plate by shallow groove bearing three to five long setae at apical edge; nasal plate expanded into large glabrous callosity; rostrum in lateral view curved downward, length ½ basal width mandibles large (Figure 16), shiny, bearing3–4 long laterally positioned setae; mandibular scar prominent, medially situated, deciduous process large (Figure 17), prominent, talon shaped, about length of rostrum, red or orange in color, maxillae rarely visible (Figure 18), hidden by small projections of the head capsule at ventrolateral angles of oral cavity; cardo stout, as wide as long; maxillary palps three segmented, 2.0X as long as wide, I and II bearing single setae on buccal side, labium not covered by prementum (Figure 18), subquadrate, as long as wide, external surface smooth; labial palps three segmented, inserted at apex of labium; palpomeres gradually reduced in size toward apex, bearing short fine setae on apical margin. Antennae (Figure 19); insertion at apical

edge of rostrum (Figure 2). Scrobe curved downwards 20–30°, deep at initiation in apicodorsal region, poorly defined through most of length, ending in basolateral region ventrad of apical margin of eye, separated from eye by scrobe's width; antennae 11 segmented, color red to orange; scape clavate with bulbous region extending from ⅔ of eye on up, otherwise slender; directed ventrad of eye in resting position, length reaching apical margin of prothorax, passing just below eye, bearing elongate setae; funicle (including peduncle) seven segmented, as long as scape, densely pilose with hairlike setae; funicular antennomers I and II clavate, 2.0X as long as other antennomers; antennomers III to VII conical, either subequal in length or regressing in size to antennomer V, then increasing in size; club three segmented, ⅓ length of scrobe, 3.0–4.0X long as wide, covered in dense setae, club segments decreasing in length and width apically. Pronotum transverse (Figure 1), greatest width about ⅔ along; dorsal surface densely punctate, each puncture bearing scale or seta; sides with lateral margins subparallel, rounded near midpoint; posterior margin straight to gently sinuate, as wide as anterior margin; in lateral view dorsal outline flattened about 1.5X long as ventral outline, anterior margin straight; scutellum conspicuous (Figure 20), triangular, covered in scales; mesepisternum triangular, densely covered with scales; metepisternum trapezoidal, suture concealed by dense scales, of greatest width at anterior edge, diminishing to parallel sided band along metesternal suture; metepimeron not visible, entirely covered by elytron. Abdominal sternites with dense coating of pearlescent scales (Figure 26); ventrites I–II connate, III–V separate; II shorter than I, subequal to III; III longer than IV; V subequal in length to I, subtriangular, covered with dense hair like setae; anterior margin of I and suture between II and III bisinuate, other margins straight. Procoxae contiguous, close to anterior margin of prothorax. Legs subequal in length (Figure 21), front legs appear shorter as protibia arcuate, uniformly covered with pearlescent white, elongate setiform

scales; femora stout, unarmed, approximately 1.5X length of pronotum, about 4.0X long as wide, proximal ¾ gradually widening then abruptly narrowing at tibial condoyle; tibia arcuate, ventral margin flared, bearing row of spiniform setae increasing in length ventrally; mucro ⅓ size of tarsal claw; corbal open, surface glabrous; tarsi ventrally with dense cover of setae; tarsomeres I and II subtriangular, I larger than II, III deeply bilobed, 2.0X wide as II, IV miniscule, ⅜ size of II, concealed by III, V elongate, lacking setae pad, as long as I and II combined; claws connate, otherwise simple. Elytra length in dorsal view 2.0X greatest width, 2.0X width of pronotum (Figure 22); anterior margins straight; humeri prominent, roundly angulate, 1.5X width of posterior margin of pronotum; lateral margins parallel anteriorly, gently diverging in middle ⅓, converging to point at apical ⅓; apex pointed; declivity gradual, convex with 10 complete striae; stria separated by width of tibia; interstrial punctures shallow (Figure 23), hidden by scales, separated longitudinally by diameter of puncture, bearing single, small, recumbent setae just before anterior side of puncture(Figure 23); stria covered in scales (Figure 24). Scale color pattern variable by species and individual; straight, erect setae or more elongate scales arranged in rows along mid region of stria, longitudinally placed at every third interstrial puncture; interval X produced along apical ⅓ of elytra. Wings fully developed (Figure 25), 2.0X length of elytra, in repose folded inward at middle of anterior edge by sclerotized elbow, poorly veined. Genitalia with Spiculum gastrale stylus longer than pedon and aedeagus (Figure 27), thin with hooked anterior end; hook turning 90°, reaching ⅓ length of stylus; laminae on apical ⅛ of stylus, abruptly widening out from stylus, bearing single blunt sclerotized projection on each wing; tegmen apodeme shorter than those of aedeagus (Figure 28), blunt tipped; posterior ring thin, unarmed; aedeagus pedon length to width ratio 6–1; anterioventral margin weakly sclerotized, mesally curved; lateral margins curved ending in lengthened point covered by long

fine setae; Ostium elongate, ovate, highly arcuate, laterally emarginated, terminating in abrupt narrow point with slight ventral curvature; apodemes subequal pedon, partially embedded in lateral folds of pedon, sclerotized throughout, forming into wide paddles anteriorly.

Female.

Generally similar to male except length 5.0–10.0 mm, average 6.9 mm, same proportions as male except where noted below; protibia straight with gentle sloping arch extending from ⅔ along tibia to outer apical angle, otherwise same as male; abdominal sternite II expanded to length of sternites III and IV combined (Figure 30), other features identical; sternum VIII with spiculum ventral long (Figure 31), stylate; lamina triangular, arms entire, weakly sclerotized. Anterior margin significantly curved; lateral margins elongate, converging into blunt point at posterior; point and lateral margins bearing relatively long fine setae; ovipositor with coxites heavily sclerotized throughout (Figure 32), only marginally longer than wide, bearing sparse fine setae along edge; spermatheca variable in size, comma or C shaped, apically sclerotized with small projection perpendicular to ramus; ramus subconical; cornu short, tightly to loosely recurved, subcylindrical.

Distribution.

Common in pine forests in the temperate Palearctic and Nearctic regions. In the Nearctic, distributed from New Brunswick and British Columbia south to Baja California and Arizona in the west and in the east reaching as far south as Indiana and Pennsylvania east of the Rocky Mountains (Bright and Bouchard 2008). Not present in the southeastern United States. In the Palearctic, found as far north as southern Poland and from England to Japan (Yunikov 2013, Kono and Morimoto 1960). Most common in the Western Mediterranean, reaching as far south

as the Atlas Mountains in Morocco, Algeria, and Tunisia (Hustache 1946, Hoffman 1961). Associated with species of pines but may also be found on Douglas fir (*Pseudotsuga menziesii*) (Bright and Bouchard 2008).

Biology.

Despite being a potential pest on economically important hosts, the biology of *Pachyrhinus* remains little studied. The damage the genus is known to cause its host is apparently not permanent (Furniss and Carolin 1977). Jensen and Koehler (1969) reported that adult *P. californicus* first appear in late February and can be found until early May. Maximum numbers are reached around late February to early March. The adult beetles feed on the needles of *Pinus* spp.; specifically, *P. californicus* feeds on Monterey pine, *P. radiata* D. Don. Adult feeding results in intermittent notches along the needle's length and causes death of the needle beyond the damaged area (Burke 1937). Severely affected trees have a brownish appearance until the damaged needles fall off before winter. The weevils show no preference for feeding location on the tree (Jensen and Koehler 1969).

Female *P. californicus* begin to produce eggs in February and continue production until the females die off (Jensen and Koehler 1969). Males have a shorter life span than the females resulting in a one to four male to female ratio by the time of the breeding season. The females may live to August and September in captivity and continue producing fertile eggs until death, even after all the males have died. Eggs are laid in an oviposition chamber constructed from three adjacent needles glued together in a bundle by a sticky exudate produced by the female. Females produce an average of 1,200 eggs distributed among an average of 36 egg clusters (Jensen and Koehler 1969). Once the larvae hatch, they drop to the ground where they burrow into and feed on the tree's rootlets. From laboratory reared specimens, pupation has been

determined to occur in early September with adults emerging later in the month. Jensen and Koenher (1969) speculate that pupation occurs in the soil and that the weevils overwinter as adults, suggesting a two year life cycle.

The feeding habits of adult *Pachyrhinus* do not directly seem to cause lasting harm to the tree (Furniss and Carolin 1977). The attacked needles simply fall of the tree in autumn. However, larval feeding on the roots may cause more extensive damage. No studies have been done to determine the extent of the root damage caused by *Pachyrhinus* larvae.

Pachyrhinus elegans (Couper, 1865)

Figures 33-38.

Polydrusus elegans Couper, 1865a: 63; Becker, 1974:70.

Scythropus elegans: Horn, 1876: 116; Chittenden, 1890: 168; Fall; 1901: 309; Blatchley and Leng, 1916: 131; Hatch, 1971: 274; Furniss and Carolin, 1977: 336.

Pachyrhinus elegans: O'Brien and Wibmer, 1982:43; McNamara, 1991: 330; Downy and Arnett. 1996: 1485; Majka et al, 2007; Bright and Bouchard, 2008: 159.

Scythropus lateralis: Casey, 1888: 276; Fall, 1901:309. **NEW SYNONYMY**.

Pachyrhinus lateralis: O'Brien and Wibmer, 1982: 43.

Scythropus albidus: Fall, 1901: 309. **NEW SYNONYMY**.

Pachyrhinus albidus: O'Brien and Wibmer, 1982: 43.

Scythropus miscix: Fall, 1901: 309. **NEW SYNONYMY**.

Pachyrhinus miscix: O'Brien and Wibmer, 1982: 43.

Diagnosis.

Members of *P. elegans* (Figure 33) may be distinguished from those of other Nearctic *Pachyrhinus* species by the nonmottled scale pattern on the elytra (Figure 39–40) as opposed to the mottled scale patterns in *P. californicus* and *P. cinereus.* It is the only Nearctic *Pachyrhinus* species to have an iridescent green coloration, though this feature is variable (Figure 37). The

aedeagus of *P. elegans* (Figures 41–43) is less arcuate than those of *P. californicus* and *P. cinereus.* It also bears a blunt tip rather than the long tapered tip of other species. The spermatheca in *P. elegans* (Figure 44) is less tightly coiled making it C shaped rather than comma shaped as in *P. californicus.*

Description (male).

Length: 4.5–8.0 mm, average 6.0 mm (Figure 33); color black, red on legs and antennae (Figure 34); vestiture composed of elongate, appraised, contiguate, mostly nonoverlapping scales, short, recurved and long, erect setae sparsely arranged throughout body; scales (Figure 6) 2.0X long as wide, with rounded tip bearing small spines, green colored (Figure 10); scales lighter colored on underside (Figure 35) and in bands on 1st, and 7th through 10th striae (Figure 34). Antennomers III to VII conical, subequal in length (Figure 19); elytra uniformly covered in dense scales (Figure 39); scales uniform in color along strial rows; rows II through VI iridescent green in coloration, other rows lighter (Figure 40); appraised setae arranged in rows along mid region of interstria, longitudinally placed at every third interstrial puncture. Aedeagus mesally curved (Figure 41). Lateral margins gradually curved, ending in point covered by long fine setae (Figures 42–43). Ostium elongate, ovate, arcuate, laterally emarginated, terminating in blunt point with small indentation present at tip.

Description (female).

Similar to male; spermatheca C shaped (Figure 44), ramus elongate, subconical; cornu elongate, recurved, apically narrowed.

Variation.

Coloration highly variable (Figures 45-53), commonly copper (Figures 45-48) or iridescent green (Figures 49-50), blue (Figures 51-53) abundant in Northern Rocky Mountains, British Columbia and the Northwest United States; integument ranging from black to orange, corresponding with scale color; funicular antennomers either subequal in size or decreasing in size to 5th antennomer, then increasing in size.

Distribution (Figure 54).

Occurs commonly in the boreal coniferous forests of temperate North America from New Brunswick to Pennsylvania in the east and British Columbia to northern California in the west. In collections studied no specimens occurred in central regions of North America between Indiana and the Front Range of Colorado. Specimens throughout range are morphologically identical with exception of variation of scale color.

Material Examined (578 specimens).

Type Material, not examined [could not be located]

CANADA, Alberta, Banff StP. VI–10–1897/ Hubbard & Schwartz (USNM: 3 males, 6 females).

British Columbia, Goldbridge. VI–29–1942/ H. B. Leech (UCRC: 1 female); Kaslo. II–7/ R. P. Curie (CWOB: 1 female); Salmon Arm. III–24–1929/ H. B. Leech (USNM: 1 female); IV–24–1933 (USNM: 1 male); V–11–1933 (USNM: 1 female); Salmon Arm. IV–4–1934; (USNM: 14 male, 13 female); Vernon. IV–17–1934/ H. B. Leech (USNM: 1 female); Aspen Grove. V–14–1934/ Ponderosa pine, H. B. Leech (USNM: 1 male, 1 female); V–25–1934/ Ponderosa pine,

(USNM: 1 male); Salmo. VI–27–1942/ H. B. Leech (UCRC: 1 female); Falkland. V–18–1944/ H. B. Leech (UCRC: 1 male, 1 female); Sirdar. IV–12–1980/ I. Askevold (CWOB: 3 males, 2 females); Fry Cr. below Bridge, Purcell Mtns. Wilderness Pk. V–28–2010/ R. W. Baumann (CWOB: 1 male); Summit Cr. Hwy. 3, Blazed Cr. rest area. VI–2–2010/ R. W. Baumann (CWOB: 1 female); Sanca Cr. Hwy. 3A, S of Sanca. VI–1–2010/ R. W. Baumann (CWOB: 1 female).

Ontario, Arkell. IV–30/ H. H. Holmes (USNM: 1 female); Pettit**.** Hubbard and Schwartz (USNM: 2 males, 3 females); Trenton**.** J. D. Evans (USNM: 2 males, 4 females); W. Robinson (USNM: 3 females); Toronto. J. R. Ciew (CUIC: 2 males, 1 female, 4 undetermined); Belleville. (CUIC: 2 males, 2 females).

USA, California, Amador Co., Tragedy Spring, Hwy. 88. VI–21–2006/ S. M. Clark & M. H. Goodman (CWOB: 1 female); El Dorado Co., S fk. American R., Hwy. 50, Riverton. III–21–1985/ R. W. Baumann (CWOB: 1 male); Flume, vic. of Pacific House. V–26–1989/ R. D. Gordon (USNM: 15 males, 1 female); Glenn Co., Plaskett Sta. VI–30–1967/ W. Gagne (CWOB: 1 female); Modoc Co., Soup Springs. V–22–2007/ B. C. Kondratieff, R. W. Baumann (CSUC: 1 female); Mono Co., 3 mi N of Mammoth Lakes. D. G. Kissinger (USNM: 5 males, 7 females); Napa Co., Mt. St. Helena. V–30–1915/ F. E. Blaisdell (CLR: 1 female); Placer Co., Dutch Flat. III–9–1909/ (UCRC: 1 male); Shasta Co., Hat Cr. Hwy 89 Honn campground. V–25–2007/ B. C. Kondratieff, R. W. Baumann (CSUC: 2 females); Trinity Co., V–20–1934/ F. R. Platt (UCRC: 1 male); Tulare Co., Giant Forest. 1904/ Wickham (USNM: 2 males, 2 females).

Colorado, Boulder Co., Eldora. VI–19–1982/ Ponderosa pine, G. H. Nelson (CWOB: 1 male); Left Hand Canyon. IV–19–2005/ B. C. Kondratieff. (CSUC: 1 male); Clear Cr. Co., Argentine Rd. Wickham. (USNM: 1 female); Jefferson Co., Lookout Mtn. VII–3–1927/ A. Nicolay

(USNM: 1 female); V–25/VI–14–2010/ CO dept. AG. (CSUC: 1 female); Larimer Co., 31 km. W Ft. Collins. IV–25–1972/ dwarf mistletoe, R. B. Penfield (USNM: 1 female); V–2–1972/ dwarf mistletoe, R. B. Penfield (USNM: 1 female); 2 mi. S, NW of Mt. Margaret trail, Red Feather Lakes area, CR74E 1 mi. off Parvin Lake. V–28–2010/ ponderosa pine, D. Leatherman. (CSUC: 1 male, 10 females); Park Co., N Fk. IV–16–1926/ H. G. Dyar (USNM: 1 female); Sada Cr. Pike NF, VII–19–1931/ (USNM: 1 female); Ward Co., nr. Ward. VI–2/VI–9–1933/ H. G. and H. E. Rodeck (CWOB: 1 male).

Idaho, Benewah Co., St. Maries. IV–30–1963/ ponderosa pine (USNM: 1 female); Boise Co., Boise NF. V–18–1954/ Ponderosa pine (USNM: 1 male, 1 female); Idaho City. VI–26–1958/ Alpine fir, W. E. Cole (1 female); Deadwood R. at Jct. S fk. Payette R. W of Loman. IV–23–1985/ R. W. Baumann & Nelson (CWOB: 1 male); Boise NF, N43.5637° W115.3976°. V–13–2015/ White Pine, J. S. Benzel (5 females); Greyback Gulch, N43.4823° W115.5158°. V–13–2015/ Ponderosa, J. S. Benzel (8 males, 7 females); N43.4590° W115.5520°. V–13–2015/ Douglas fir, J. S. Benzel (12 males, 8 females); Bonner Co., Sand Point. V–23–1899/ U. S. Hopkins (USNM: 1 females); Bonner Co., Coeur d'Alene. IV–22–1920/ ponderosa pine, J. O. Evenden (USNM: 4 males, 7 females); Bonner Co., Sandpoint. VI–8–1950/ N. M. Downie (CWOB: 2 males, 4 females, 1 undetermined); VI–11–1954/ N. M. Downie (USNM: 2 females); VI–10/ VII–10–1971, (CWOB: 1 male, 6 females); VI–19–1973, (CWOB: 1 female); VII–15–1969 (CWOB: 2 male); VI–19–1973 (USNM: 1 male, 5 females); VII–9–1974/ N. M. Downie (CWOB: 1 female); Clark Co., Fairfield. VII–6–1960/ D. R. Smith (USNM: 1 male, 1 female); Idaho Co., Lochsa R., hwy. 12, Wendover campground. IV–28–1992/ R. W. Baumann & Zenger (USNM: 1 female); Latah Co., Moscow. V–20–1928/ J. E. Shull (USNM: 1 male); IV–20–1929/ H. A. Waters (USNM: 2 females); IV–29–1950/ N. M. Downie (UCRC: 1 male, 1

undetermined)' Big Sand Cr. V–7–1975/ R. Haswell (USNM: 8 males, 15 females); Shoshone Co., Cedar Mtn., Moscow. IV–15–1934/ M. C. Lane (UCRC: 6 males, 3 females, 1 undetermined); Shoshone Co., Cathedral Peak, 11 mi SW of Heron Montana. VII–2–1962/ western white pine. D. G. Hellin (USNM: 3 males, 1 female); Valley Co., Krassel. V–23–1959/ M. M. Furniss (USNM: 2 males, 6 females).

Maine, Cumberland Co., Douglas Hall. V–7/V–8–1916/ A. S. Nicolay (USNM: 1 male, 3 females); Oxford Co., Porter. VI–12/A. E. Brower (USNM: 7 males, 6 females).

Massachusetts, Essex Co., Lawrence. VI–1864/ white pine (1 male, 1 female); N of Sangus. VI–1906/ H. M. Russel (1 female); Lawrence. (CUIC: 4 undetermined); Franklin Co., Charlemont**.** IV/ (USNM: 2 female); Middlesex Co., Tyngsborough. V–17–1933/ (CUIC: 4 undetermined); Worcester Co., Southborough. V–8–1927/ C. A. Frost, (CUIC: 1 male)

Montana, Beaverhead Co., above Wise R. V–30–1933/ L. J. Liu & R. W. Baumann (CWOB: 3 males, 6 females); Gallatin Co., V–13–1902/ R. W. Cooley (USNM: 1 female); Gallatin Co., Bozeman. VI–6–1912/ R. W. Cooley (USNM: 1 female).Granite Co., Sliderock Mtn. 16 mi SE of Clinton. V–18–1910/ whitebark pine, D. G. Fellen (USNM: 1 male: 1 undetermined); Flint Cr. Mtns., Racetrack Pk. VI–30–1961/ S. M. Sutton (CWOB: 1 female); Bonner. V–20–1958/ Western Larch, R. E. Denton (USNM: 2 males, 3 females); Lake Co., N of Polson. VI–22–1977/ Douglas fir, S. Kohler (USNM: 1 female); Lewis & Clark Co., Blackfoot R., Hwy. 279. V–21–1993/ R. W. Baumann & L. J. Liu (CWOB: 2 males, 2 females); Helena. IV–14/V–5–1978/ Hubbard & Schwartz (USNM: 2 males, 2 females); Missoula. IV–20–1914/ ponderosa pine, J. Brunner (USNM: 2 males, 1 female, 1 undetermined); nr. Frenchtown. VI–13–1977/ Douglas fir, S. Kohler (USNM: 2 females); Ravalli Co., Gird Cr. IV–23–1933/ W. L. Jellison (USNM: 1 female); Burch Cr. IV–8–1934/ W. L. Jellison (USNM: 1 female) Sleeping Child Cyn. V–3–

1937/ W. L. Jellison (USNM: 1 female); Gird Cr. IV–27–1941/ W. L. Jellison (USNM: 2 females); Bass Cr. Florence. IV–22–1979/ grand fir, S. Koeler (USNM: 1 males, 1 females).

New Hampshire, Cheshire Co., Mohadrock. G. G. Milling (USNM: 1 male); Grafton Co., Hanover. (USNM: 1 male), Rockingham Co., Hampton. I–14/ S. A. Shaw (USNM: 1 male, 1 female), Stafford Co., Durham. (USNM: 2 females), Sullivan Co., Claremont. VI/ (USNM: 7 males, 10 females).

New Jersey, [no data] (USNM: 2 females).

New York, Erie Co., Buffalo. (USNM: 2 females); Essex Co., Cold R., High Peaks Wild Area, Saranac R. V–11–2006/ L. Myers (CSUC: 1 male, 1 female); Tompkins Co., Ithaca. V–5–1895/ Chitenden (USNM: 6 males, 7 females, 1 undetermined); IV–26–1915/ (CUIC: 1 male); 1937/ J. C. Bradley (CUIC: 6 males, 3 females); W Danby. V–30–1915/ (CUIC: 1 female); Westchester Co., Rye L. VI–3–1934/ H. L. McIntyre (USNM: 2 female);

Ohio, [no data] (USNM: 1 female).

Oregon, Baker Co., Baker. VI–2–1939/ J. H. Baker (USNM: 4 males, 9 females); Pine Cr. V–8–1945/ J. H. Baker (USNM: 1 female). VI–14–1945 (USNM: 1 female); Crook Co., Ochoco NF. V–27–1933/ M. C. Lane (USNM: 6 males, 7 females); Deschutes Co., 20 mi. S of Bend. V–27–1964/ K. Goeden (CWOB: 1 males, 1 females); Douglas Co., 15 mi W of Diamond L. VI–29–1971/ A. E. Lewis (CWOB: 1 male); Jackson Co., 10 mi. S of Ashland. IV–16–1959/ K. Goeden (USNM: 1 female); Squaw L. V–19–1962/ J. Schuh (USNM: 1 male); Hwy. 230, 14 mi N of Union Cr. VII–1–1971 (CWOB: 1 female); Klamath Co., Ft. Klamath. V–26–1933/ McLane (USNM: 2 males, 1 female) Lake Co., Squaw Butte Cr. Hwy 140 E Lakeview. V–20–2013/ B. C. Kondratieff (CSUC: 7 males, 6 females); Lincoln Co., Newport. V–3–1965/ lodge pole pine,

K. Goeden (CWOB: 2 females); Umatilla Co., Meacham. V–13–1933/ M. C. Lane (USNM: 42 males, 31 females); Union Co., Blue Mtns. VI–11–1940/ C. A. Frost (USNM: 4 males, 2 females).

Pennsylvania, Franklin Co., Mt. Alto. V–6/ J. N. Knull (USNM: 2 males, 2 females); Warren Co., Bear L. (USNM: 1 female).

Utah, Cache Co., Logan Cyn. VI–6–1933/ G. F. Knowlton (USNM: 1 male); Duchesne Co., Argyle Cr. Argyle Cyn. VI–15–1999/ R. W. Baumann (CWOB: 1 male, 1 female).

Washington, Kittitas Co., Easton. V–18–1931/ ponderosa pine, W. W. Baker (USNM: 3 males, 2 females); Kittitas Co., Easton. / A. Koebele (USNM: 5 males, 3 females); Okanagan Co., Okanogan NF., Early Winters RS. V–30–1966/ D. S. Horning Jr. (CWOB: 1 female); Pierce Co., Mt. Rainier NP, Glacier Bridge. V–30–1997/ B. C. Kondratieff. (CSUC: 1 male); Spanaway**.** May–30–1925/ ponderosa pine, W. W. Baker (1 male, 1 female); Walla Walla co., Walla Walla. May–1933/ M. C. Lane (4 males, 7 females); Yakima Co., Tampico. May–30–1925/ M. C. Lane (1 female).

Wyoming, Teton Co., SE entrance, Yellowstone NP. VI–19–1947/ J. H. Baker (USNM: 1 female).

Biology.

Main hosts are white pine, western white pine, and Ponderosa pine (*Pinus strobus* L., *P. monticola* D. Don. and *P. ponderosa* Douglas ex C. Lawson). Found on a variety of other pines and Douglas fir (Bright and Bouchard 2008).

Remarks.

Two species of *Pachyrhinus*, *P. lateralis* and *P. miscix*, have holotypes morphologically identical to confirmed specimens of *P. elegans. Pachyrhinus lateralis* (Figures 55-60) was described from a single specimen taken at Lake County, California. It was differentiated from *P. elegans* by Casey (1888) who cited a more transverse and depressed prothorax and tumid elytral humeri (Figure 55). An examination of the holotype revealed the left side of the pronotum is cracked and dislocated, resulting in the appearance of a more depressed prothorax (Figure 56). The elytral humeri were within the individual variation found in *P. elegans*.

Pachyrhinus miscix (Figures 61-66) is similar to *P. lateralis*, especially when the holotypes are compared. This species was differentiated from *P. elegans* by Fall (1901) citing a less arcuate front and middle tibia in the male (Figure 62), a longer fourth funicular joint, and a more transverse thorax and hirsute abdomen (Figure 63). Comparisons of the holotype and of other specimens identified as *P. miscix* with *P. elegans* indicate that these features to fall within the range of individual variation for *P. elegans*. The more arcuate tibia is a sexual feature common to the males of all *Pachyrhinus* species and the relative sizes of the funicular joints were variable even within series of the material examined. The more hirsute abdomen is variable with females and more abraded specimens having less hirsute sternites. The holotype of *P. lateralis* exhibits all of these features.

The lectotype of *P. elegans* was not available for examination. This species was originally represented by a series of syntypes in the collection of W. Couper (Couper 1865b). Couper's collection was scattered after his death and the locations of many of its specimens are currently unknown (Becker 1973). The syntypes of *P. elegans* were rediscovered in the

Seminary du Quebec in 1971. Becker (1973) designated a lectotype for *P. elegans*. The Seminary was unresponsive to requests for loans or information.

Pachyrhinus californicus (Horn, 1876)

Figures 67-72.

Scythropus californicus Horn, 1876, 117. Fall (1901:309); Hatch (1971:2750); Furniss and Carolin (1977:335).

Pachyrhinus californicus, O'Brien and Wibmer (1982:43); McNamara (1991: 330); Bright and Bouchard (2008:159).

Scythropus ferrugineus Casey, 1888: 276. Fall (1901:309); Hatch (1971:275).

Pachyrhinus ferrugineus, O'Brien and Wibmer (1982:43).

Diagnosis.

Pachyrhinus californicus is characterized by the presence of orange, gold or grey scales about 2X long as wide or longer (Figure 67). On the elytra, these are placed in a mottled pattern with grey or white scales 2X long as wide. This species can be differentiated from the morphologically similar *P. cinereus* by more elongate and tapered scales (Figures 73-74) as opposed to the blunt teardrop shaped scales of *P. cinereus,* and by the intermittent greatly lengthened scales or long setae found at intervals along the elytral striae as opposed to the smaller recumbent scales found intermittently on the elytra of *P. cinereus. P. californicus* can be distinguished from *P. elegans* by the mottled scale pattern on the elytra contrasting the ordered scale coloration of *P. elegans* with each stria containing scales of a uniform color. The aedeagus of *P. californicus* (Figures 75-77) is more curved than in *P. elegans* and has a blunt tip rather

than the tapered tip of *P. elegans.* The spermatheca of *P. californicus* (Figure 78) is C shaped rather than comma shaped as in *P. cinereus.*

Description (male).

Length 5.0–8.0 mm, average 6.33 mm (Figure 67); color uniformly orange (Figure 68); scales 4.0X long as wide (Figure 7), setiform, ribbed with ribs terminating in spines at end of scale, orange; mottled patches of white scales, 2.0X long as wide on elytra; pearlescent scales on ventral and lateral portions of body (Figure 69), 2.0X long as wide. Funicular antennomers III to VII conical, subequal in length. Elytra covered in nonuniform patches of scales (Figure 73); scales elongate (Figure 74), setiform, 4.0X as long as wide, tapered, densely packed, orange, arranged in a mottled pattern with patches of stout white scales interspaced with primary scale type; white scales most common along 1st and 7th–10th stria; long appraised setae arranged in rows along mid region of stria, longitudinally placed at every third interstrial puncture. Aedeagus mesally curved (Figure 75); lateral margins curved, ending in lengthened point covered by long fine setae (Figure 76–77); ostium elongate, ovate, highly arcuate, laterally emarginated, terminating in abrupt narrow point with slight ventral curvature.

Description (female).

5.0–9.0 mm average 6.9 mm. Spermatheca C shaped (Figure 78), apically sclerotized with small projection perpendicular to ramus; ramus short, subconical; cornu short, recurved, subcylindrical.

Variation (Figures 79-82).

Scale coloration variable, ranging from ash grey (Figure 79) to gold (Figure 80) and reddish orange (Figure 81-82); scale morphology variable, follows local trends through range of *P. californicus,* specimens from Coastal and Klamath mountains (Figure 81) have patches of setiform scales around elytral humeri; specimens from Sierra Nevada, and Cascade Mountains have wider scales (Figures 81-82), 3.0X long as wide; scales may be missing, resulting in rubbed appearance; funicular antennomers either subequal in size or decreasing in size to 5th antennomer, then increasing in size.

Distribution (Figure 83).

Occurs in conifer forests in California, Oregon, and Washington. This species has also been recorded from British Columbia.

Material Examined (656 specimens).

HOLOTYPE: USA, California, El Dorado Co. G. H. Horn (male) (MCZC).

CANADA, British Columbia, Vernon. IV–17–1934/ ponderosa pine, H. B. Leech (USNM: 5 males, 12 females); Vancouver I., Naniamo. IV–12/ Taylor (USNM: 2 males).

California, Alameda Co., Hills back of Oakland. IV–13–1927/ E. C. Zimmerman. (USNM: 1 female); IV–26–1930, (USNM: 1 male, 3 females); Berkeley. II–26–1932/ E. C. Zimmerman. (USNM: 2 females); II–18–1934/ Monterey pine, F. R. Platt (UCRC: 1 male, 4 females); III–12–1939/ F. D. Horn (UCRC: 1 female); III–20–1934/ M. Cozier (UCRC: 1 female); Oakland. I–12–1940/ R. Dahl (EMEC: 4 males); I–20–1944/ R. Schuster (EMEC: 1 female) III–9–1952/ Monterey pine (EMEC: 7 males, 7 females); I–21–1958/ Monterey pine, D. J. Burdick (CWOB:

2 males); I–29–1959/ Monterey pine, C. W. O'Brien (CWOB: 2 males); Berkeley Hills NE Oakland. II–4–1964/ J. Powell (EMEC: 2 males); Redwood Regional pk. II–14–1965/ M. J. Tauber and C. A. Toschi (EMEC: 6 males, 6 females); San Pablo dam. II–15–1966/ Monterey pine/ R. W. Browne (EMEC: 1 male, 4 females); Calaveras Co., nr. Dorington. V–29–1957/ H. Ruckes Jr. (CWOB: 1 female); Contra Costa Co., Mt. Diablo. IV–1934/ L. W. Saylor (USNM: 2 females); Walnut Cr. V–24–1952/ pine/ J. J. Menn (EMEC: 1 male); IV–9–1958/ D. J. Burdick (CWOB: 2 males, 3 females); V–12–1962/ C. W. O'Brien (CWOB: 2 males); San Pablo Reservoir. IV–1966/ Monterey pine, G. L. Jensen (6 males, 5 females); Mt. Diablo. IV–28–1974/ D. S. Green. (EMEC: 1 female); El Dorado Co., Placerville. III–16–1915/ ponderosa pine, F. B. Herbert (USNM: 4 females); II–8–1916/ incense cedar, (USNM: 1 female); Georgetown. IV–5–1960/ sugar pine, R. W. Stark (CWOB: 1 female); 1 mi. E Pollock pines. V–28–1989/ R. D. Gordon (UCRC: 2 males, 4 females); 1 mi E of Pacific House. VI–29–1991/ C. B. Barr (EMEC: 2 females); 2 mi. SE of Pacific House. IV–21–1996/ Douglas fir, L. G. Bezark (CWOB: 4 females); Blodgett Forest Rest Sta., 12 mi E of Georgetown, El Dorado Conduit. VI–5/ VI–6–2004/ C. B. Barr, C. S. Chaboo & K. W. Will (UCRC: 1 female); Humboldt Co., Forest Home. II–10–1966/ M. W. Stone (UCRC: 1 female); Bair's Ranch, Redwood Cr. VI–19–1903/ H. S. Barber. (USNM: 5 females); VI–19–1903 (USNM: 2 female); V–15–1911/ H. M. Nunemacher. (USNM: 2 females); Eureka. VI–2/ H. S. Barber. (USNM: 1 male, 1 female); VI–3 (USNM: 1 male); VI–4 (USNM: 1 male, 7 females); Bair's Ranch, Redwood Cr. VI–6/ H. S. Barber. (USNM: 1 female); VI–13/ yellow pine (USNM: 4 males, 9 females); Butte Cr. Hwy 36. V–2–2011/ B. C. Kondratieff. (CSUC: 5 males, 8 females, 1 undetermined); Inyo Co., Lone Pine. V–9–1937/ W. C. Reeves (EMEC: 1 male, 1 female); Lake Co., Cow Mountain. II–12–1955/ D. J. Burdick (EMEC: 6 males, 5 females); Los Angelis Co., Los Angelis. VII–11–1930/ E. C.

Zimmerman (USNM: 1 female); Marin Co., Laurel Dell camp. IV–1–1961/ G. W. Frankie. (EMEC: 9 males, 10 females); 7 mi. S of Olema. II–22–1965/ Douglas fir, C. W. O'Brien (CWOB: 1 male, 1 female); Mt. Tamalpais. III–15–1969/ Douglas fir, C. W. O'Brien (CWOB: 4 male, 5 female); Alpine L. Liberty Gulch. IV–1–1971/ R. Hilsop (EMEC: 1 female); IV–16–1971/ R. Coville (EMEC: 1 female); IV–20–1974/ Douglas fir, J. Powell. (EMEC: 5 males, 6 females); IV–20–1974/ M. Kirby. (EMEC: 1 male); IV–20–1974/ C. Magowin. (EMEC: 1 female); IV–20–1974/ L. Rhudy (EMEC: 1 female); IV–19–1975/ C. Kellner (EMEC: 1 female); IV–17–1976/ A. Thayer (EMEC: 1 female); IV–17–1976/ K. L. Collingene (EMEC: 1 female); IV–30–1976/ E. Giesbert (EMEC: 1 female); IV–16–1978/ Douglas fir, J. Powell. (EMEC: 7 males, 7 females); Five Brooks, N37°59'48 W122°45'31. V–18–2015/ Douglas fir, J. S. Benzel. (CSUC: 2 males, 2 females); Mariposa Co., Yosemite Valley. V–26/VI–21–1921/ E. C. Zimmerman (USNM: 9 males, 12 females); IV–3–1960/ D. M. Fanara (USNM: 1 male); Mendocino Co., Willits. IV–1–1946/ E. E. Johnston (USNM: 1 male); IV–17–1957/ yellow pine, C. B. Eaton (USNM: 1 male, 5 females); Mendocino. V–22–1957/ J. R. Helfer (CWOB: 1 male, 1 female); XII–2–1957/ J. R. Helfer (CWOB: 1 female); Caspar. II–27–1958/ J. H. Helfer (CWOB: 1 male, 1 female); Cleone. III–18–1958/ J. Helfer (CWOB: 1 male); Ham pass Rd. 2.5 mi. NW of Eel R. VI–13–1972/ J. Doven. (EMEC: 1 male, 4 females); NCCRP 3 mi. N of Branscomb. V–8 –1976/ G. Hunter (EMEC: 1 female); V–12/ V–14 –1978/ R. J. Dare (EMEC: 1 male); IV–18/ IV–20 –1980/ S. E. Ludwig (EMEC: 2 females); IV–18/ IV–20 –1980/ S. Meridith (EMEC: 2 females); V–30/ VI–1 –1980/ C. Monteller (EMEC: 1 female); V–30/ VI–1 –1980/ C. Parisek (EMEC: 1 female); V–30/ VI–1 –1980/ W. C. Schaupp (EMEC: 1 female); Masonite rd. 11.65 mi W of Ukiah. IV–4–1981/ Douglas fir, W. J. A. Volney et al. (EMEC: 1 female); Masonite rd. 11.1 mi W of Ukiah. IV–16–1981/ W. J. A. Volney et al. (EMEC: 1 male,

3 females); Angelo Reserve 8 km N of Branscomb, Walker Meadow. V–29/2–VI–2003/ S. Lew (EMEC: 2 females); Wilderness Lodge. V–31–2003/ Douglas fir, J. Powell (EMEC: 1 female); Modoc Co., Jackson St. Pk., N41. 3757° W120.9536°. V–15–2015/ J. S. Benzel (CSUC: 3 males, 5 females); Mono Co., Mammoth. V–1–1919/ Jeffery pine, Shoemaker (USNM: 4 males, 2 females); Monterey Co., Chews Rdg. nr White Oak Camp. V–8–1975/ R. Warton (EMEC: 3 females); Carmel. III–13–1915/ Wickham (USNM: 2 females); 1918/ Shoemaker (USNM: 1 male, 1 female); III–24–1919/ Wickham (USNM: 6 female); V–14–1921/ A. Nicolay (USNM: 1 male, 5 females); Nevada Co., Nevada City. V–14–1971/ (UCRC: 1 female); Placer Co., III–6–1913/ E. J. B. (USNM: 1 female); Flume, Meadow vista, Placer hills road. V–27–1989/ R. D. Gordon (UCRC: 3 males); Greenhorn Cr., Hwy 70 SE Quincy. IV–25–2010/ B. C. Kondratieff, R. W. Baumann (CSUC: 1 male, 2 females); Rio Blanco Co., Pied–Jous, S slope site #83BB47. V–1976/ pinyon pine, B. E. King (CWOB: 1 male, 2 females); Sacramento Co., Sacramento. II/ A. Koebele (USNM: 5 males, 2 females); San Bernardino Co., San Bernardino NF, Barton Flat. V–24–1956/ Jeffery Pine, B. J. Adelson (CWOB: 1 female); Lake Arrowhead. IV–April–1962/ Jeffery Pine, C. O. Eads (UCRC: 1 male); Seven Oaks. V–12–1962/ M. Kajiyama (UCRC: 1 female); Barton Flats. IV–28–1965/ M. W. Stone (UCRC: 1 female); III–18–1971/ M. W. Stone (UCRC: 1 female); San Mateo Co., Lake Pilarcitos. III–20–1965/ C. W. O'Brien (CWOB: 1 male); San Luis Obispo Co., 1 mi. NE of Cambria. III–24/III–25–1980/ J. A. Powell (EMEC: 2 females); San Mateo Co., Ano Nuevo St. Reserve. IV–27–2002/ Monterey pine, J. Powell (EMEC: 1 female); Santa Clara Co., Loma Prieta. III–9–1965/ Douglas fir, R. E. Browne. (EMEC: 1 male); IV–16–1964/ Douglas fir, (EMEC: 1 male); IV–26–1966/ Douglas fir, (EMEC: 1 female); Los Gatos. Hubbard & Schwartz. (USNM: 1 female); Santa Cruz Co., Ben Lomond. IV–6–1931/ L. W. Saylor (USNM: 3 males, 5 females); IV–1–1932 (USNM: 1 male, 1 female);

Santa Cruz. IV–3–1932/ L. W. Saylor (USNM: 1 female); Big Basin St. Pk. III–26–1966/ B. Tilden (CWOB: 2 males, 1 female); Siskiyou Co., 5 mi. S of Mt. Hebron. VI–7–1960/ Yellow pine, J. Schuh (USNM: 2 females); Sonoma Co., 4 mi. W of Plantation. IV–4–1956/ D. J. Burnick (EMEC: 1 female); Mt. St. Helena. V/ L. Saylor (USNM: 8 males, 9 females); Del Puerto Cyn., 20 mi W of Patterson. II–18–1961/ knobcone pine, W. Gagne (CWOB: 1 female); Trinity Co., Ruth L. IX–1–164/ Spadoni (EMEC: 1 female); East side Rd., Trinity R. V–3–2011/ B. C. Kondratieff (CSUC: 2 females, 1 undetermined); Tulare Co., Johnsondale. IV–27–1964/ W. Turner (EMEC: 5 males, 10 females, 1 undermined); Sequoia NF, N36. 0912° W118.3600°. V–18–2015/ J. S. Benzel (CSUC: 1 male); Yuba Co., 4 mi. NE of Dobbins. IV–7–1956/ K. S. Hagen (EMEC: 1 male).

Oregon, Jackson Co., Butte Falls. IV–25–1913/ ponderosa pine, W. D. Edmonston (USNM: 2 males, 1 female); Klamath Co., 20 mi. W of Klamath Falls. V–18–1955/ F. P. Larson (USNM: 1 female); Upr. Klamath marsh, Military Crossing. V–11–1956/ J. D. Vertroes (USNM: 1 female); Kobele Co. From Dept. of Agriculture (USNM: 1 female); Lane Co., Eypt Forest, 6 mi E of Eugene. XI–13/VI–13/ Douglas fir, H. J. Andrews (USNM: 11 males, 4 females); Andrews Exp. Forest, 11 mi NE of Blue R. IV–11–1979/ Douglas fir, G. M. Cooper (USNM: 1 male, 1 female); Washington Co., Forest Grove. III–28–1919/ M. C. Lane (USNM: 1 male); Yamhill Co., McMinnville. III–15/ III–20–1940/ C. A Frost (USNM: 4 males, 1 female).

Washington, Walla Walla Co., Kooskooskie. IV–6–1949/ (USNM: 3 males, 3 females); Yakima Co., Tieton Dam. V–13–1927/ M. C. Lane (USNM: 1 female).

Biology.

Feeds on several species of *Pinus* including ponderosa pine, Jeffery pine (*P. jefferyi* Balf.), and Monterey pine (*P. raddei* D. Don) as well as Douglas fir.

Remarks.

The holotype of *P. californicus* (Figures 67-73) has orange elytral integument rather than the more typical black integument common among members of *P. californicus* at the type locality in the Sierra Nevadas. However, this lighter coloration occurs in other parts of the range of *P. californicus* and was found in series collected at the type locality.

Bright and Bouchard (2008) synonymized *P. ferrugineus* (Figures 84-89) with this species after examination of the holotype of *P. ferrugineus*. In the original description *P. ferrugineus* was distinguished from *P. californicus* by more sparse, setiform scales 4.0X long as wide or longer (Figure 88) and a longer fifth sternite (Figure 86). The setiform scales are common on specimens collected at the type locality, Muir Woods, Marin County, California and the Coastal and Klamath mountains (Figure 82). The longer fifth sternite is indicative of a female specimen in all the Nearctic members of the genus and bears no value as a specific character (Figure 23). Sparse scales regularly occur as individual variation within a series among all Nearctic members of *Pachyrhinus*. Bright and Bouchard (2008) found the holotype of *P. ferrugineus* to be rubbed and found no differences in the genitalia of specimens attributed to both *P. californicus* and *P. ferrugineus*. Further comparisons and dissections confirm the synonymy proposed by Bright and Bouchard (2008).

Pachyrhinus cinereus (Casey, 1888)

Figures 90–95.

Scythropus cinereus: Casey, 1888: 276; Fall, 1901: 309.

Synonymy

Scythropus crassicornis Casey, 1888: 276. Fall, 1901: 309. **NEW SYNONYMY.**

Pachyrhinus crassicornis, O'Brien and Wibmer 1982:43.

Scythropus albidus Fall 1901: 309. **NEW SYNONYMY.**

Pachyrhinus albidus: O'Brien and Wibmer 1982:43.

Diagnosis.

Pachyrhinus cinereus (Figure 90–95) is similar to *P. californicus* but can be distinguished by the blunt teardrop shaped scales on the elytra (Figure 8) along with thickened and blunt recumbent or slightly appraised elongate scale interspersed along the elytral interstria (Figures 96–97). In *P. californicus* the scales are elongate with tapered ends and are occasionally setiform. Specimens of *P. cinereus* have a mottled scale color pattern as opposed the uniformly colored interstria of *P. elegans.* The aedeagus of *P. cinereus* (Figures 98–100) is identical to that of *P. californicus* in being highly arcuate with a blunt tip. *Pachyrhinus elegans* in contrast has a moderately curved aedeagus with a long tapered tip. The spermatheca (Figure 101) is comma shaped rather than C shaped as in *P. elegans*.

Description (male).

Length: 5.0–7.0 mm average 6.0 mm (Figure 90); color black, red on tibia tarsi and antennae (Figure 91); scales about 1.5X long as wide with blunt tips, teardrop shaped (Figure 8), color gold, ash grey scales on underside (Figure 92), sides, and mottled spots on elytra. Funicular antennomers III to VII conical, regressing in size to V, increasing in size thereafter. stria uniformly covered in scales (Figure 96); scales formed into mottled color pattern with patches of teardrop shaped gold scales 2.0X long as wide mottled with patches of ash grey scales of the same dimensions (Figure 97); grey scales most common on stria I and VII–X. Aedeagus mesally curved (Figure 98); lateral margins curved, ending in lengthened point covered by long fine setae (Figures 99–100); ostium elongate, ovate, highly arcuate, laterally emarginated, terminating in abrupt narrow point with slight ventral curvature.

Description (female).

Length 5.0–9.0 mm average 6.5 mm. Spermatheca comma shaped (Figure 101); ramus elongate, subconical; cornu elongate, recurved, apically narrowed.

Variation (Figures 102–105).

Scale color variable, ranging from ash grey (Figure 103) to gold (Figures 104–105) and orange (Figure 105); color of the primary scales may closely match that of the secondary scales on the underside and in mottled patches on the elytra giving the appearance of a uniform scale color (Figure 102). The more elongate scales that appear periodically on the interstria show some variation in size ranging from nearly identical to the surrounding scales to elongate and slightly appraised. The scales themselves are more loosely attached to the integument than in other species of *Pachyrhinus* resulting in some older *P. cinereus* lacking most of their scales and

having a “rubbed” appearance. In New Mexico some *P. cinereus* are smaller ranging from 4.5 to 5 mm in body length but otherwise identical.

Distribution (Figure 106).

Pachyrhinus cinereus is common in mountain coniferous forests along the Rocky Mountains from New Mexico to Montana and into Alberta and British Columbia and west to the Sierra Nevada.

Material Examined (493 specimens).

HOLOTYPE, USA, California, Tahoe Co. T. L. Casey (female) (USNM).

CANADA, British Columbia, Vernon. IV–22/ Wickham (USNM: 1 female); North Bend. VI–6/ Hubbard & Schwartz (USNM: 1 female).

USA, Arizona, Apache Co., Jackson Spring near Alpine. VI–4–1982/ R. W. Baumann (CWOB: 1 female); Nutrioso Cr. Hwy. 180 below Alpine Divide. VI–20–1987/ R. W. Baumann, B. C. Kondratieff, Sargent, & Wells (CWOB: 1 male). Cochise Co., Chiricahua Mtns., Onion Saddle V–4–1978/ R. Gordon (USNM: 2 females). Coconino Co., Williams. V–20/ Barber & Schwartz (USNM: 1 male); V–26 (USNM: 1 male, 11 females); V–27 (USNM: 3 males, 10 females); V–28 (USNM: 1 male, 3 females); V–29 (USNM: 2 males); V–30 (USNM: 1 male, 1 female); VI–6 (USNM: 3 females); VI–8 (USNM: 1 female); VI–12 (USNM: 1 female); San Fran Mtns. VI–8–1915 (USNM: 1 female); Tusayan NF., V–7–1915 (USNM: 2 males, 1 female); San Fran. Mtns. V–8–1915/ ponderosa pine, M. R. Wagner (CUIC: 2 male, 1 female). Flagstaff. IV–24–1916/ ponderosa pine, C. F. Korstain (USNM: 10 males, 21 females, 1 undetermined). V–5–1947/ R. S. Beal (CWOB: 1 male). IV–27–1983/ ponderosa pine, M. R. Wagner (2 males, 1 female). VI–10–1995/ W. B. Warner (CWOB: 2 females); III–7/ Barber & Schwartz (USNM: 1

female). Navajo Co., Winslow. V–10–1968/ ponderosa pine, P. E. Buffam (USNM: 1 males, 2 females); Apache NF. V–5–1934/ ponderosa pine, U. S. Hopkins (USNM: 7 males, 3 females); White Mtns., Diamond Cr. VI–1925/ D. Duncan (USNM: 2 females); Pima Co., Catalina Mtns., Hitchcock Hwy. mi 22. V–22–1958/ C. W. O'Brien (CWOB: 1 male). Yavapai Co., Lynx Cr. 10 mi, N of Prescott. IV–29–1936/ ponderosa pine, H. Morrison (USNM: 2 females) Oak Cr. VI–14–1948/ M. W. Stone (UCRC: 1 female); Prescott. III–26–2011/ long leaf pine, C. W. O'Brien (CWOB: 3 males, 1 female); VI–19/ Barber & Schwartz (USNM: 1 male, 1 female).

California, Alameda Co., Arroyo Mocho; 20 mi. S Livermore. III–2–1953/D. Burdick. (EMEC: 1 female); V–24–1957/ (CWOB: 1 male); Arroyo Mocho 10 mi S of Livermore. III–2–1958/ P. D. Ashlock (CWOB: 2 females); Arroyo Mocho, 17 mi. SE of Livermore. II–18–1967/ knobcone pine, W. Gagne (CWOB: 1 male, 2 females. EMEC: 1 female); Cedar Mtn. III–3–1968/ Digger pine, J. Powell. (EMEC: 2 males, 2 females); Mt. Santini. VII–3–1971/ Timberlake (UCRC: 1 female); Alpine Co., Bear Valley. VI–6–1914/ R. S. Woglum (UCRC: 4 females); Butte Co., Bangor. III–28– 1955/ K. S. Hagen. (EMEC: 2 males, 1 female); Calaveras Co., Rail Road Flat. VI–17–1974/ G. S. Linsley. (EMEC: 1 female); Chico Co., Bidwell Park. IV–14–1974/ S. R. Palten. (EMEC: 1 female); Contra Costa Co., 4 mi. N of Orinda Russel Property. III–14–1966/ C. Slobodenkoff (CWOB: 2 males, 1 female); Tilden Pk. Inspiration point. IV–8/ IV–18–1992/ Monterey pine, W. Middlekauff (EMEC: 4 males, 8 females); El Dorado Co., Placerville. III–6–1913/ E. J. B. (USNM: 1 male); nr. Whitehall. V–21–1931/ E. C. Zimmerman (USNM: 1 female); Lake Tahoe. VII–11–1931/ E. C. Zimmerman. (USNM: 1 female); Blodgett Forest 13 mi. E of Georgetown. V–29–1971/ (EMEC: 4 females); V–29–1977/ ponderosa pine. J. Yoakley. (EMEC: 1 female); S Fk. American R., Hwy 50 Riverton. III–23–1985/ R. W. Baumann (CWOB: 5 males, 2 females); Blodgett Forest 14 mi. E of Georgetown. IV–27–1985/.M. C.

Whitmore. (EMEC: 1 female); 2.3 mi NE Virner. III–20–1996/ L. G. Bezark (CWOB: 5 males, 3 females). Ogilvy Cyn. Cr., SE of Pacific House. IV–21–1996/ L. G. & E. A. Bezark (CWOB: 2 females). Pacific House. III–1–1997/ L. G. Bezark (CWOB: 2 males); Mormon Emigrant Trail, 2–3 mi from Sly Park. III–2–1998/ L. G. & E. A. Bezark (CWOB: 3males, 3 females); El Dorado NF, N38.4623° W120.2328°. V–18–2015/ ponderosa pine, J. S. Benzel (CSUC: 2 males, 4 females); 1 mi S of Meyers. V–26/ D. G. Kissing. (USNM: 2 females). Fresno Co., Long Meadow Cr. At Hume L. III–16–1985/ R. W. Baumann (CWOB: 1 male); Humboldt Co., Forest Home. III–10–1966/ M. W. Stone (CWOB: 1 female); Inyo Co., Onion Valley. VI–17–1937/ J. H. Mitchell (CWOB: 1 male). Coyote Ridge. VI–26–1976/ E. Giesbert (EMEC: 1 female). Kern Co., Mt. Pinos. VII–2–1955/ G. A. Gorelick (CWOB: 1 female). W of Wofford Hts. IV–28–1964/ W. Turner. (EMEC: 2 females). Tehachapi Mt. Co. campground. V–6–1965/ Doyer. (EMEC: 3 females). Lake Co. Whispering Pines. IV–18–1964/ W. Turner. (EMEC: 1 female); V–19–1964/ R. F. Luck (CWOB: 1 female); Lassen Co., Laufman St. 3 mi. SE Milford. V–17–1982/ J. A. Powell. (EMEC: 4 females); Gold run Cr. Gold run Rd. SW Susanville. V–22–2007/ B. C. Kondratieff, R. W. Baumann. (CSUC: 1 female); Marin Co., Bodega Bay. II–6–1988/ J. K. Robertson (EMEC: 4 male, 9 female); Mariposa Co., Yosemite. 5–28–1931/ D. W. Clancy (UCRC: 1 female); Big Meadow. III–20–1969/ D. L. Tiemann. (EMEC: 1 female); Modoc Co., NW of Canby. VI–24–1960/ E. L. Schlinger (UCRC: 2 females) S Fk. Parker Cr. FRd. 31. V–22–2007/ D. Leatherman. (CSUC: 2 males, 2 females); Mono Co., Blanco's Corral, WhiteMtn. VI–27–1953/ H. Nalahibarra (UCRC: 1 female); Monterey Co., Prunedale. I–1965/ Monterey Pine, C. Kohler (CWOB: 1 male); Nevada Co., IV–13–1963/ L. V. & T. L. Erwin (UCRC: 1 male); Grass Valley. V–13–1971 (UCRC: 3 males); 5 mi. SW grass Valley. V–6–1980/ ponderosa pine and Jeffery pine, J. T. Doyen and J. K. Liebherr (EMEC: 1 male, 7 females);

Donner Picnic Area. N39°22'41 W120°09'42. V–19–2015/ ponderosa pine, J. S. Benzel (CSUC: 1 female); Placer Co., Forest Hill. IV–1898 (USNM: 2 males, 1 female); Dutch Flats. II–28–1909 (UCRC: 3 females); Flume, Dog Bar Rd. V–27–1989/ R. Gordon (USNM: 2 males, 1 female); Plumas Co., 7 mi N of Chester on Juniper L. Rd. VI–4–1964/ T. L. Erwin (CWOB: 1 female); Benner Cr. VI–5–1964/ T. L. Erwin (CWOB: 1 female); NW Chester on Benner Cr. VI–1–1965/ T. L. Erwin (CWOB: 2 males); VI–11–1965, (USNM: 2 females); Squirrel Cr. 8 mi E of Quincy. V–15–1982/G. W. Urlich. (EMEC: 1 male, 1 female); Humbug Cr. 3 mi. W of Portola. V–16–1982/ J. A. Chemsak. (EMEC: 8 males, 8 females); San Bernardino Co., Near Fallsvale, San Gorgonio Mtn. VI–23–1964/ J. D. Pinto (UCRC: 1 female); Running Springs. VI–9–1965/ J. T. Doyen (EMEC: 1 female). USA, CA, Bear Lake. VII–5–1932/ M. W. Stone (UCRC: 1 female); Seven Oaks. V–13–1962/ H. Ewing (UCRC: 1 female); San Luis Obispo Co., Paso Robbles. Shoemaker (USNM: 3 males, 4 females); Santa Barbara Co., San Marcos Pass. IV–14–1960/ E. I. Schinger and J. C. Hall (UCRC: 1 female); Orcutt. III–5/ III–25–1966/ A. J. Kissler (USNM: 7 males, 6 females); Mt. Hamilton. V–6–1957/ D. Burdick (CWOB: 1 male); Santa Clara Co., Los Gatos. III–30–1962/ T. L. Erwin (USNM: 1 male); Mt. Hamilton. VII–14–1967/ knobcone pine, W. Gagne (CWOB: 1 male); Siskiyou Co. V–29–1911/ F. W. Nunenache (USNM: 1 female); Sonoma Co., Rhododendron St. Pk. IV–15–1955/ D. J. Burdick (EMEC: 2 females); 4 mi W of Plantation. IV–6–1957/ D. Burdick (CWOB: 4 male); Mt. St. Helena. V/ L. W. Saylor (USNM: 5 males, 6 females); Stanislaus Co., Adobe Cr. II–26–1948/ R. F. Smith. (EMEC: 1 male); Trinity Co., 15 mi. SW Hay Fk. IV–17–1962/ ponderosa pine, R. W. Clabaugh (CWOB: 1 male); Tulare Co., Sequoia NP. VI–1932. F. T. Scott (USNM: 1 female); Tuolumne Co., Sand Flat. VI–11–1930/ D. W. Clancy (UCRC: 1 female); VI–26–1931. H. E. Hinton (USNM: 1 female); Twain Harte. II–5–1967/ M. R. Lundgrin (EMEC: 1 male); Ventura Co.,

Chuchupate Rgr. Sta. base. Frazier Mtn. V–1–1955/ Jeffery Pine, C. W. O'Brien (CWOB: 1 female); Mt. Pinos, Campground 1. VIII–19–1970/ Jeffery pine, R. A. Medeveo (UCRC: 1 female); Sierra foothill field sta. 6 mi. N of Smartville. V–4–1980/ J. A. Powell. (EMEC: 2 males).

Colorado, Chaffee Co., Dreney Gulch. VI–24–1999/ ponderosa pine, D. Leatherman. (CSUC: 1 female); Elbert Co., Jct. CR94/CR77. VI–27–1995/ ponderosa pine, D. Leatherman. (CSUC: 2 females); Las Animas Co., Trinidad lakes St. Park N side picnic area. V–18–2012/ D. Leatherman. (CSUC: 1 male); Mesa Co., Colorado National Monument. V–11–1949/ Pinyon Pine (USNM: 3 males); Weld Co., E of CR 115 at WY line. IV–18–1994/ limber pine, D. Leatherman. (CSUC: 3 males, 9 females, 1 undetermined).

Idaho, Clearwater Co., Orofino. IV–25–1967/ ponderosa pine, G. C. Franc (USNM: 2 females); Lewis Co. Winchester. V–1–1924/ M. C. Lane (USNM: 3 males, 7 females).

Montana, Lewis & Clark Co., Helena. IV–21–1907/ W. M. Mann (USNM: 2 males).

New Mexico, McKinley Co., 1–2 mi. S of Ft. Wingate. VI–6–1988/ pinyon pine, R. Turnbow (CWOB: 1 male, 2 females); IV, (USNM: 1 female); Santa Fe Co., Santé Fe. VI–5, (USNM: 23 males, 20 females); San Juan Co., Aztec. V–5, C. F. Baker (USNM: 1 female); San Miguel Co., Las Vegas HS. III–8/ Barber & Schwartz (USNM: 1 female).

Nevada, Washoe Co., Jct. Hwy. 15 & 28. VI–27–1962/ C. W. O'Brien (CWOB: 2 males, 4 females); Whites Cr., Whites Cr. Trailhead. VI–16–2009/ B. C. Kondratieff, R. W. Baumann. (CSUC: 1 female); Thomas Cr. Rd. 49. VI–16–2009/ B. C. Kondratieff, R. W. Baumann. (CSUC: 1 female).

Oregon, Baker Co., Pine Cr. VI–8–1939/ J. H. Baker (USNM: 1 female); V–1–1940 (USNM: 1 female); V–5–1940 (USNM: 2 female); V–27–1945 (USNM: 1 male, 1 female); Columbia Co., Clatskanie. IV–14–1936/ Douglas fir, K. Grey & J. Sohuh (USNM: 6 males, 4 females); Corvallis. V–3–1936/ G. Ferguson (USNM: 1 male); Cook Co., Ochoco NF. Wiley Cr. Camp. VI–20–1998/ G. R. Ballmer (UCRC: 1 female); Grant Co., Silvies R. Highway 359. S Seneca. S Rd. 37. V–21–2013/ B. C. Kondratieff. (CSUC: 2 males, 1 female); Hood River Co., Hood River. Gresham. V–21/ C. C. Sperry (USNM: 1 female); V–21/ Hubbard & Schwartz (USNM: 8 male, 12 female); Jackson Co., Butte Falls. V–17–1956/ F. P. Larson (USNM: 1 female); Josephine Co., 6.5 mi S of Cave Jct. V–27–1980/ knobcone pine, R. L. Westcott (CWOB: 2 females); Lake Co., Fremont NF, N42.1993° W120.6161°. V–15–2015/ white pine, J. S. Benzel (CSUC: 7 males, 6 females); Klamath Co., 2 mi. NW of Chiloquin. V–17–1975/ ponderosa pine, R. L. Westcott (CWOB: 1 female); Tillamook Co., Sand Lake. V–12–1940/ K. M. Fender (USNM: 4 male, 1 female); Union Co., Kamila. VI–10–1925/ M. C. Lane (USNM: 1 male); Blue Mtns. VI–4–1933/ M. C. Lane (USNM: 4 males, 2 females); Cold Spring, Blue Mtns. T. McLane (USNM: 1 male, 1 female); Wapinita Pass. V–5–1938/ K. Grey & J. Senuh (USNM: 1 female).

Utah, Carbon Co., 415 mi. N of Price. 143. V–20–1968/ D. G. Kissinger (USNM: 1 male, 1 female); Garfield Co., 4.5 mi S Panguitch, hwy. 143. IV–23–2005/ R. Turnbow (CWOB: 4 females); Dixie NF, Canaan Peak. V–27–2003/ S. M. Clark & C. R. Nelson (CWOB: 2 female); Kane Co., Ponderosa Grove Rec Area. IV–20–2005, R. Turnbow (CWOB: 1 female); San Juan Co., 1.5 mi. W of Utah line on US 160. V–20–1968/ D. G. Kissinger (USNM: 2 females); Devil's Cyn. nr. Campground off Hwy 191. V–29–2013/ gambel oak/ W. Crenshaw, D. Leatherman & B. C. Kondratieff. (CSUC: 1 female); Sevier Co., Water Cyn. Above jct. Quitchupah Cr. IV–25–2002/ R. W. Baumann & Clark (CWOB: 2 males).

Washington, Clallam Co., Sol Duc Hot Springs. VI–11–1933, M. C. Lane (USNM: 1 female); Columbia Co., Lewis Pk., Blue Mtns. VII–11–1933/ M. C. Lane (USNM: 2 males, 2 females); Kittitas Co., Vicinity of Cle Elum. VI–25–2009/ M. Huether (CWOB: 1 female); Spokane Co., Spangle. / C. V. Piper (USNM: 1 female); Skagit Co., Cypress Is. V–27–1979/ M. Whitmore (EMEC: 1 female); Thurston Co., Tenino. / Hubbard and Schwartz (USNM: 1 female).

Wyoming, Albany Co., 1.7 mi N of Easterbrook Campground. V–19–2008/ R. Turnbow (CWOB: 3 males, 5 females); Park Co., [Yellowstone] National Park. VII–30/ Hubbard & Schwartz (USNM: 2 females).

Biology.

Similar to *P. californicus*. Feeds mainly on ponderosa pine and Douglas fir.

Remarks.

Smaller specimens of *P. cinereus* occur in New Mexico and Arizona. These were originally described as *P. crassicornis* (Figures 107-112) by Casey (1888) from a single specimen collected at Fort Wingate, New Mexico. *Pachyrhinus crassicornis* was distinguished by a shortened prothorax and a highly arcuate antennal scape only barely surpassing the posterior margin of the eye. Examination of the holotype found it to have a scape and prothorax of the normal length of *P. cinereus*, reaching to the anterior margin of the prothorax (Figure 108). In addition, specimens from the type locality were typical in size and specimens of *P. cinereus* series in other locations occasionally showed smaller size and more actuate antennae.

Pachyrhinus albidus (Figures 113-118) was described from a single specimen collected around Lake Tahoe, the same type locality of *P. cinereus*. The holotype bears a close resemblance to a *P. cinereus* with closely matching scale colors, but with only isolated scales of

the secondary scale color (Figure 113). The scale morphology is identical with that of *P. cinereus* (Figure 117).

Pilot DNA Study (Figure 119).

In order to test the proposed species concepts a DNA study was conducted on COII sequence data from recently collected specimens captured in Idaho, Oregon, and California. From this sequence data, a neighbor joining tree was produced (Figure 110). In the tree, specimens identified morphologically as *P. elegans* and *P. cinereus* clustered together while specimens of *P. californicus* failed to cluster either with each other or with either the *P. elegans*, or *P. cinereus* groups. This supports *P. elegans* and *P. cinereus* as valid species, separate from one another and from *P. californicus.* The *P. californicus* sequences grouped into multiple clusters suggesting the species is polyphyletic and in need of revision.

Key to the Nearctic species of *Pachyrhinus*

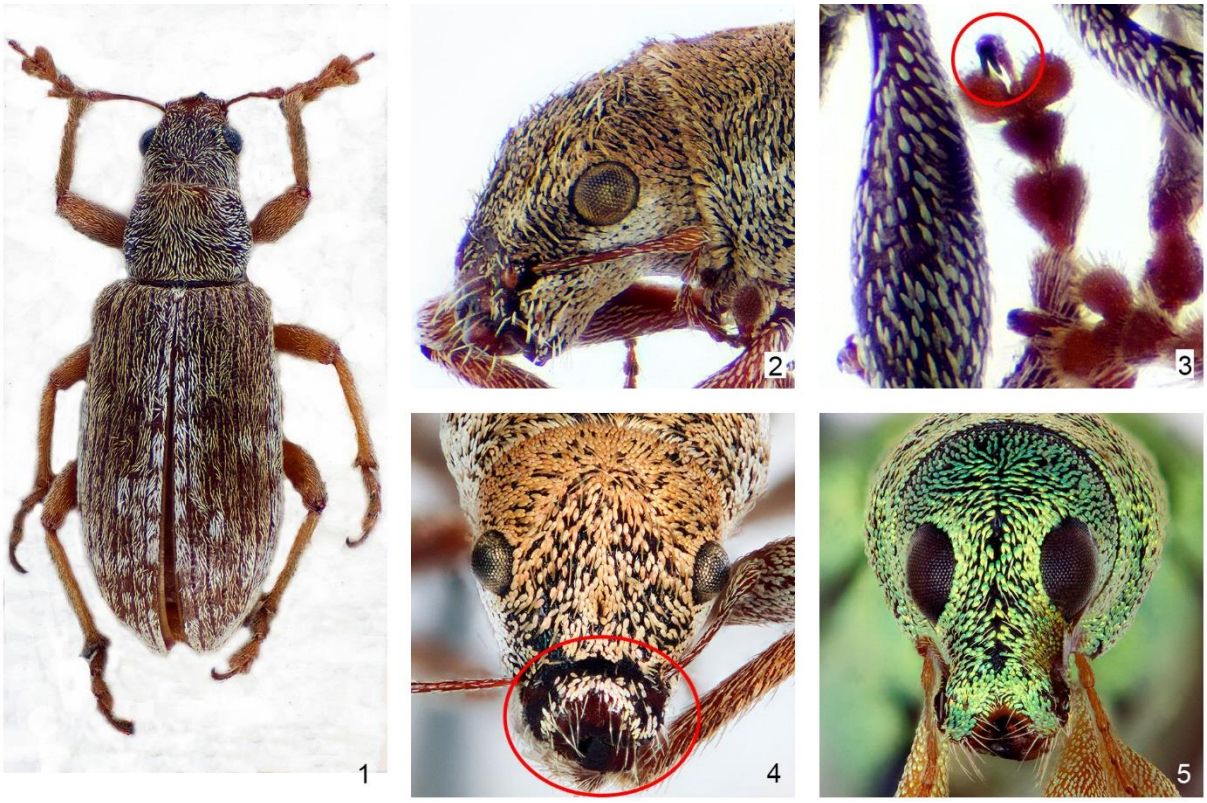
1. Scales in mottled color pattern on elytral disc (Figures 11-12). Aedeagus highly arcuate with a tapered tip (Figures 75-77).....2

1'. Scales not in mottled pattern (Figure 10). Aedeagus feebly arcuate with a wide blunt tip (Figure 41-43), Spermatheca C shaped (Figure 44). Temperate North America .....*P. elegans*

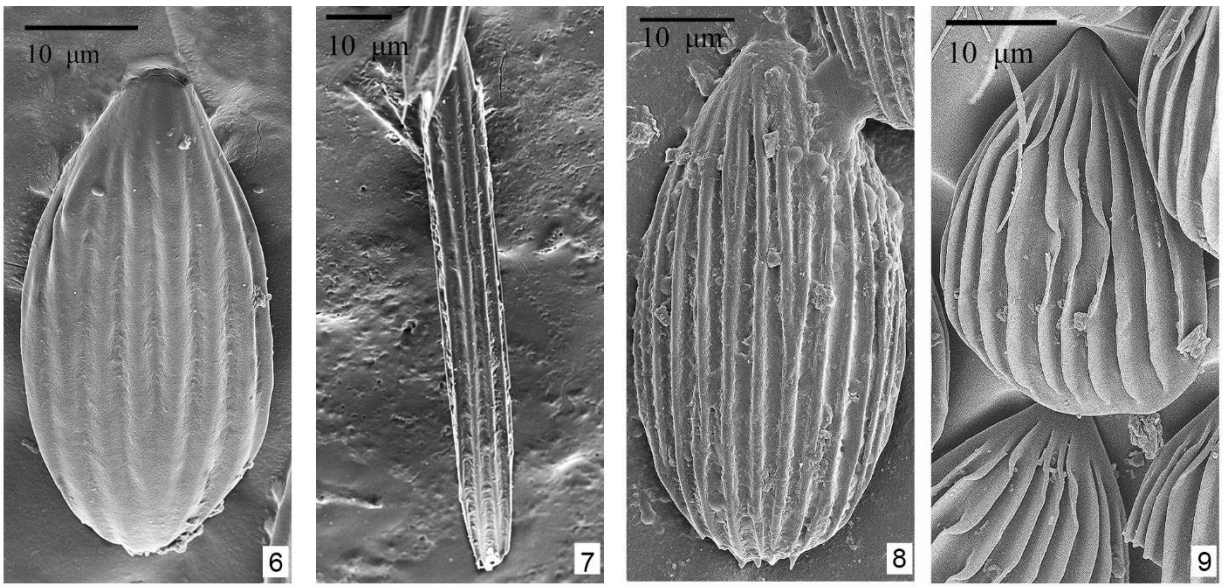
2. Scales with blunt tips, teardrop shaped 1.5X as long as wide (Figure 8). Elongate intermittent scales on elytra bluntly tipped and recumbent to slightly appraised (Figure 97). Spermatheca comma shaped (Figure 101). Western North America.....*P. cinereus*

2'. Scales 2.0 to 4.0X long as wide with tapered ends sometimes setose in form (Figure 7). Intermittent scales long, highly appraised and often setose (Figure 74) spermatheca C shaped (Figure 78), Pacific states and British Columbia.....*P. californicus*

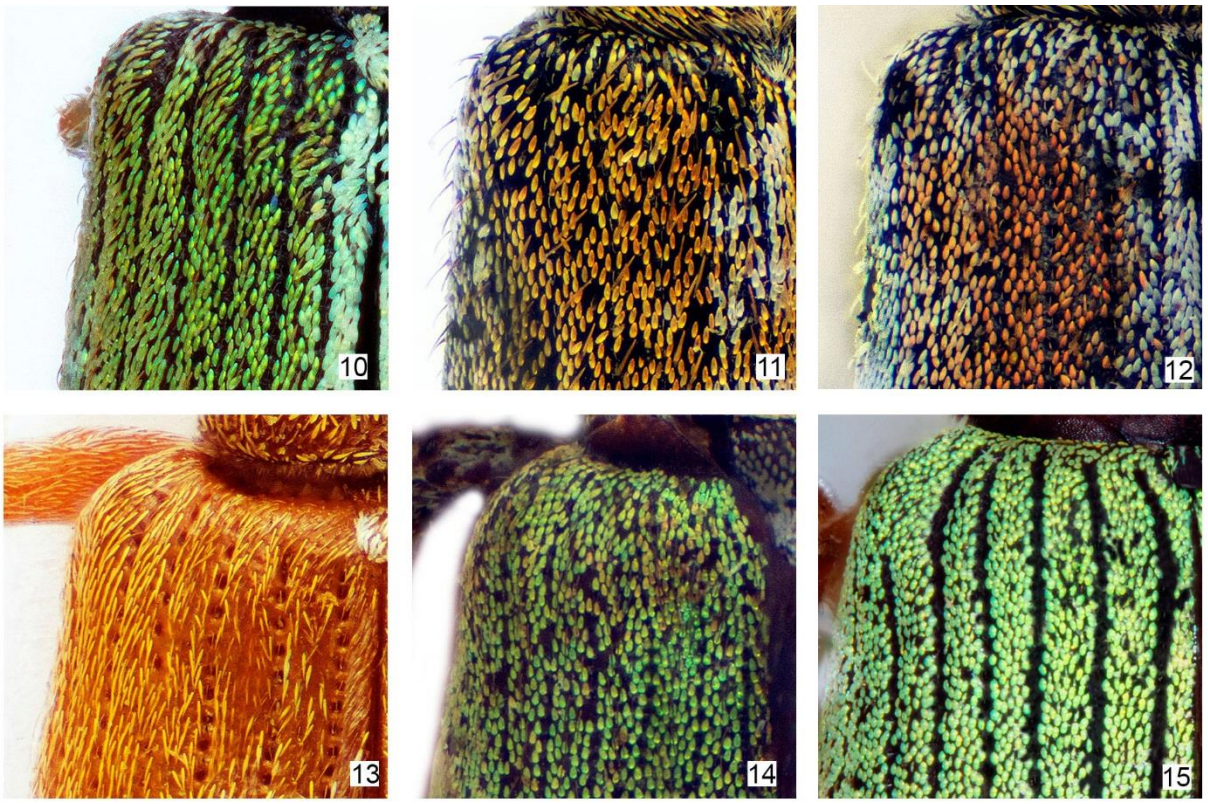
Figures and captions



Figures 1-5. 1. *Pachyrhinus squamulosus*, dorsal view (USNM). 2. *Pachyrhinus cinereus* head, lateral view of head (USNM). 3. *Pachyrhinus cinereus* tarsus showing connate tarsal claws (USNM). 4: *Pachyrhinus cinereus* head, frontal view (USNM). 5. *Polydrusus sericeus* (Schaller 1783) head, frontal view (CSUC).

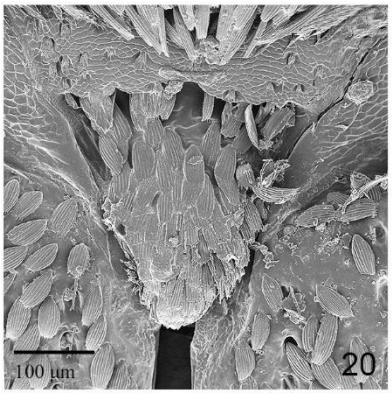


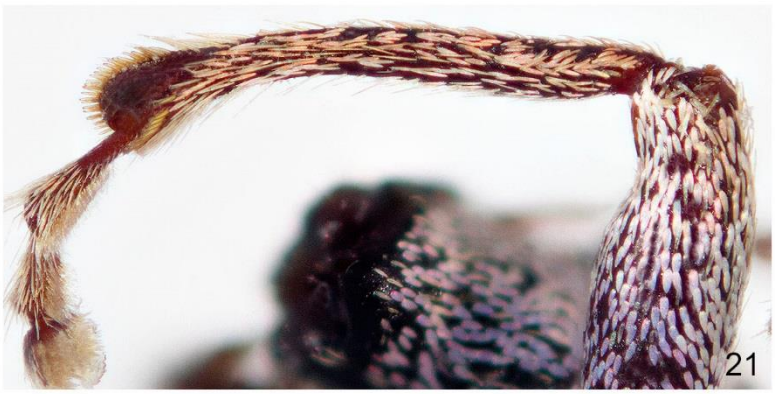
Figures 6-9. 6. *Pachyrhinus elegans* scale (CSUC). 7. *Pachyrhinus californicus* scale (CSUC). 8. *Pachyrhinus cinereus* scale (CSUC). 9. *Polydrusus impressifrons* Gyllenhall 1834 scale (CSUC).



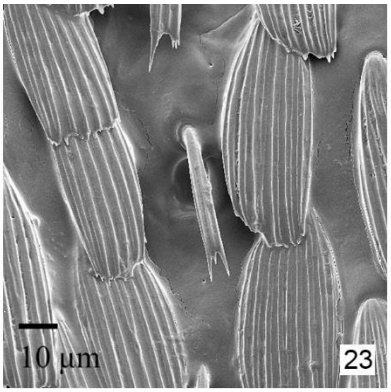
Figures 10-15. 10. *Pachyrhinus elegans* elytral scales (CSUC). 11. *P. californicus* elytral scales (CSUC). 12. *P. cinereus* elytral scales (USNM). 13. *P. squamulosus* elytral scales (USNM). 14. *P. lethierryi*, elytral scales (USNM). 15. *Polydrusus sericeus*, elytral scales (CSUC).

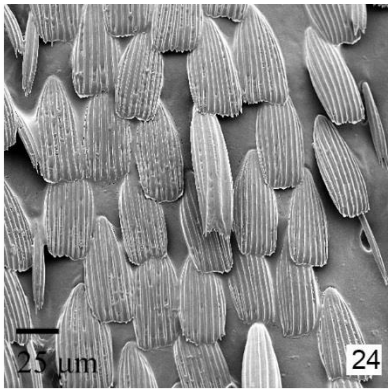
Figures 16-19. 16. *Pachyrhinus cinereus* mandibles showing scars at deciduous process attachment point (CSUC). 17. *P. californicus* mandibles with deciduous process (CSUC). 18. *P. elegans* Oral cavity with maxillae and labium (CSUC). 19. *P. elegans* antennae. Lateral view (CSUC)

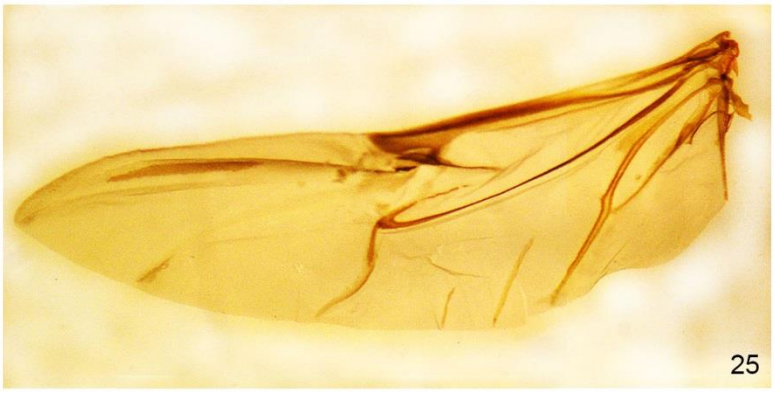




Figures 20-21. 20. *P. elegans* scutellum (CSUC). 21. *P. elegans* male protibia (CSUC).

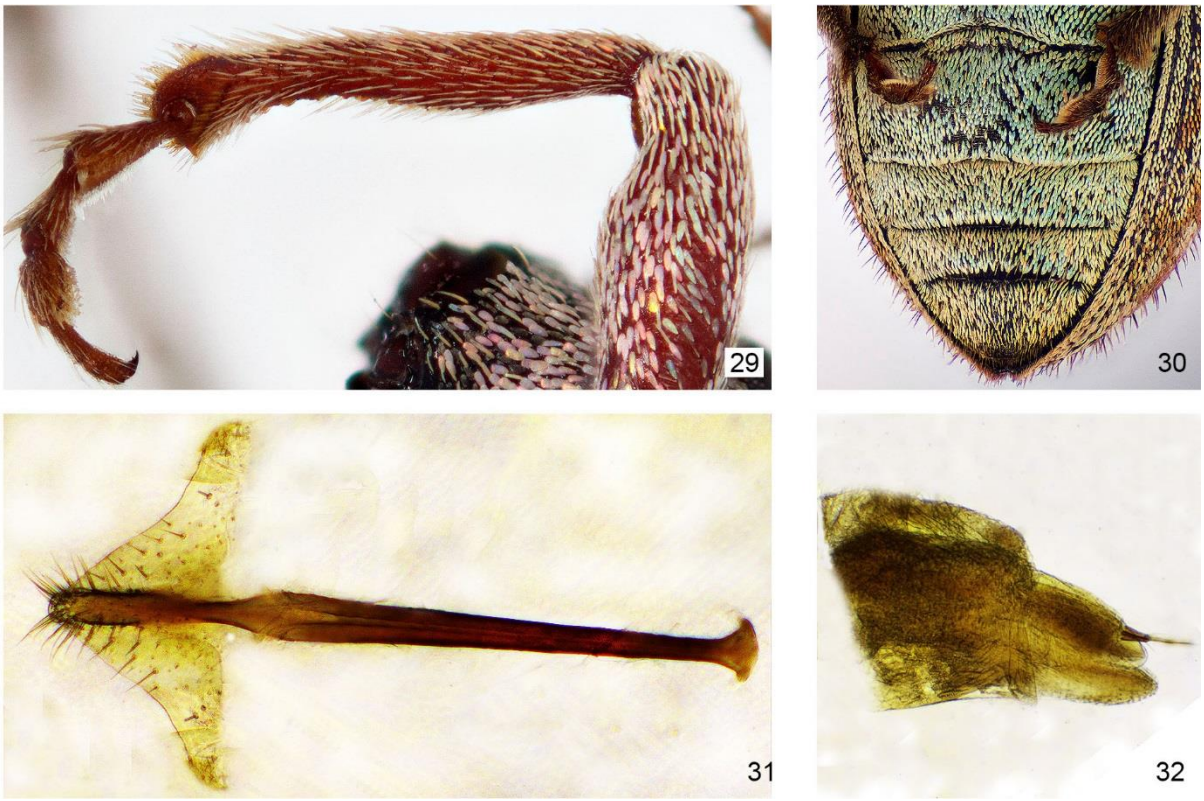




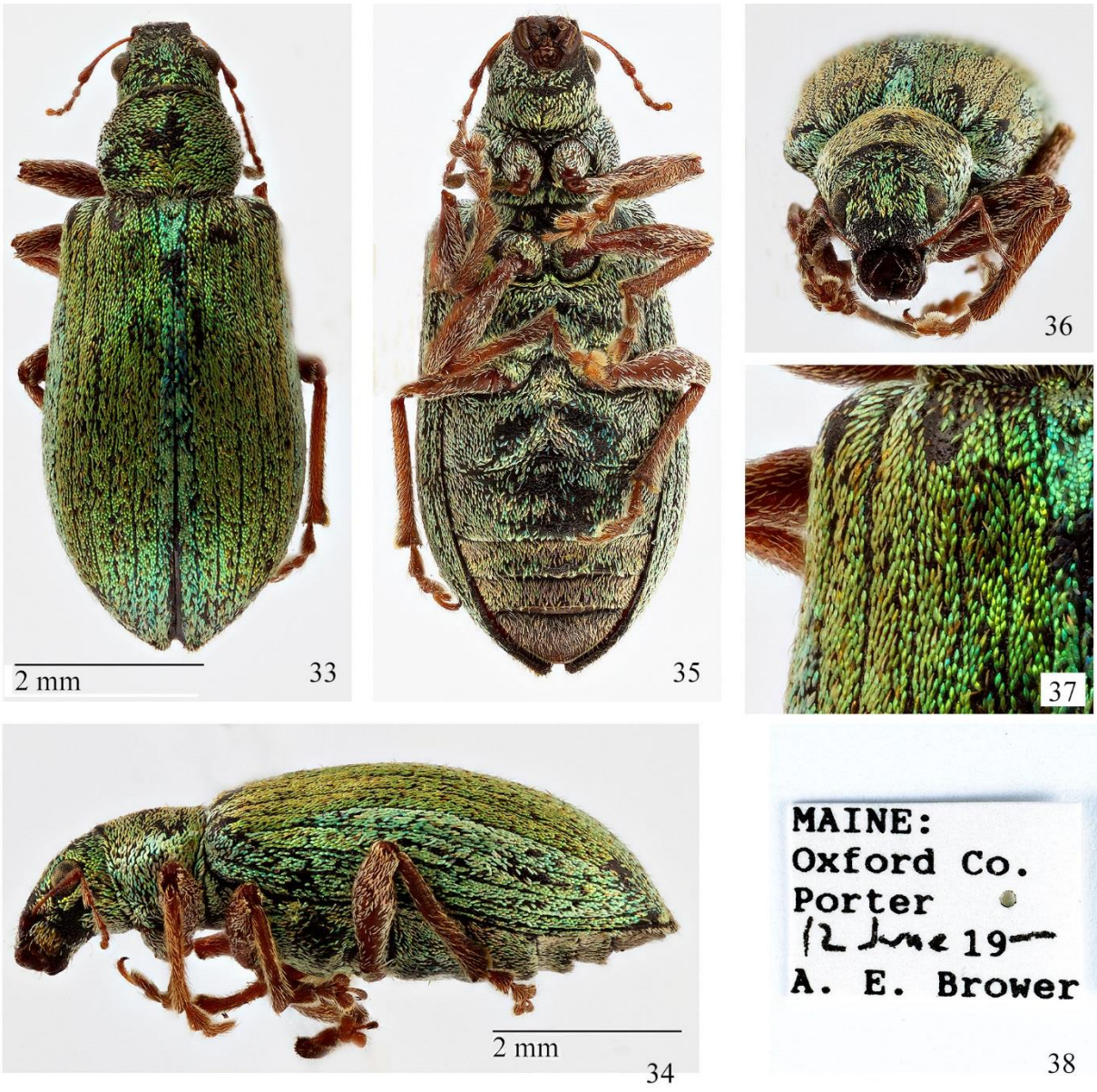


Figures 22-25. 22: *Pachyrhinus elegans* elytra (USNM). 23. *P. cinereus* puncture in elytral interstria (CSUC). 24. *P. cinereus* scales on elytral stria (CSUC). 25: *P. elegans* wing (CSUC).

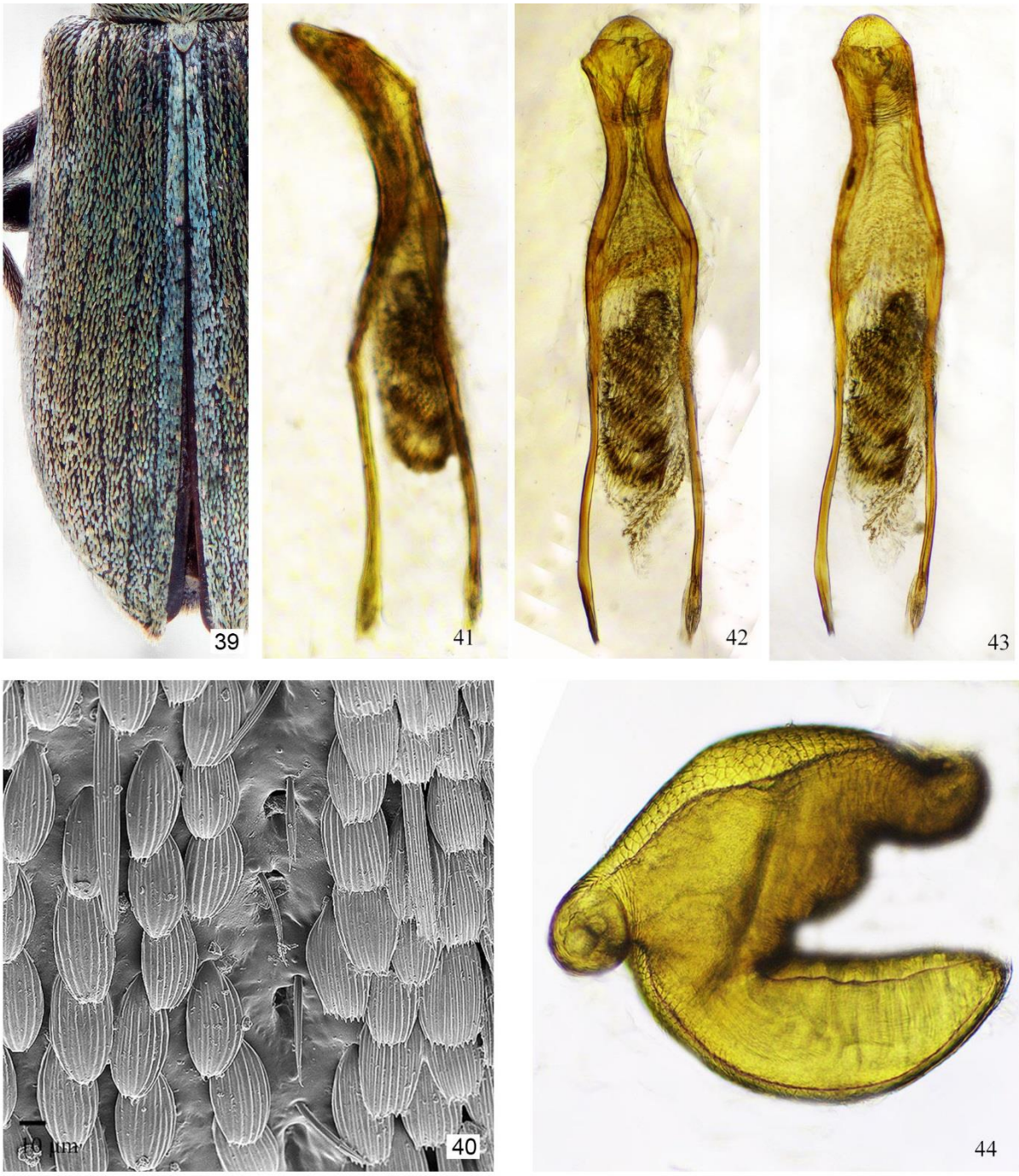
Figures 26-28. 26. *Pachyrhinus elegans* abdominal sternites (CSUC). 27. *P. elegans* spiculum gastrale (CSUC). 28. *P. elegans* tegmen (CSUC).



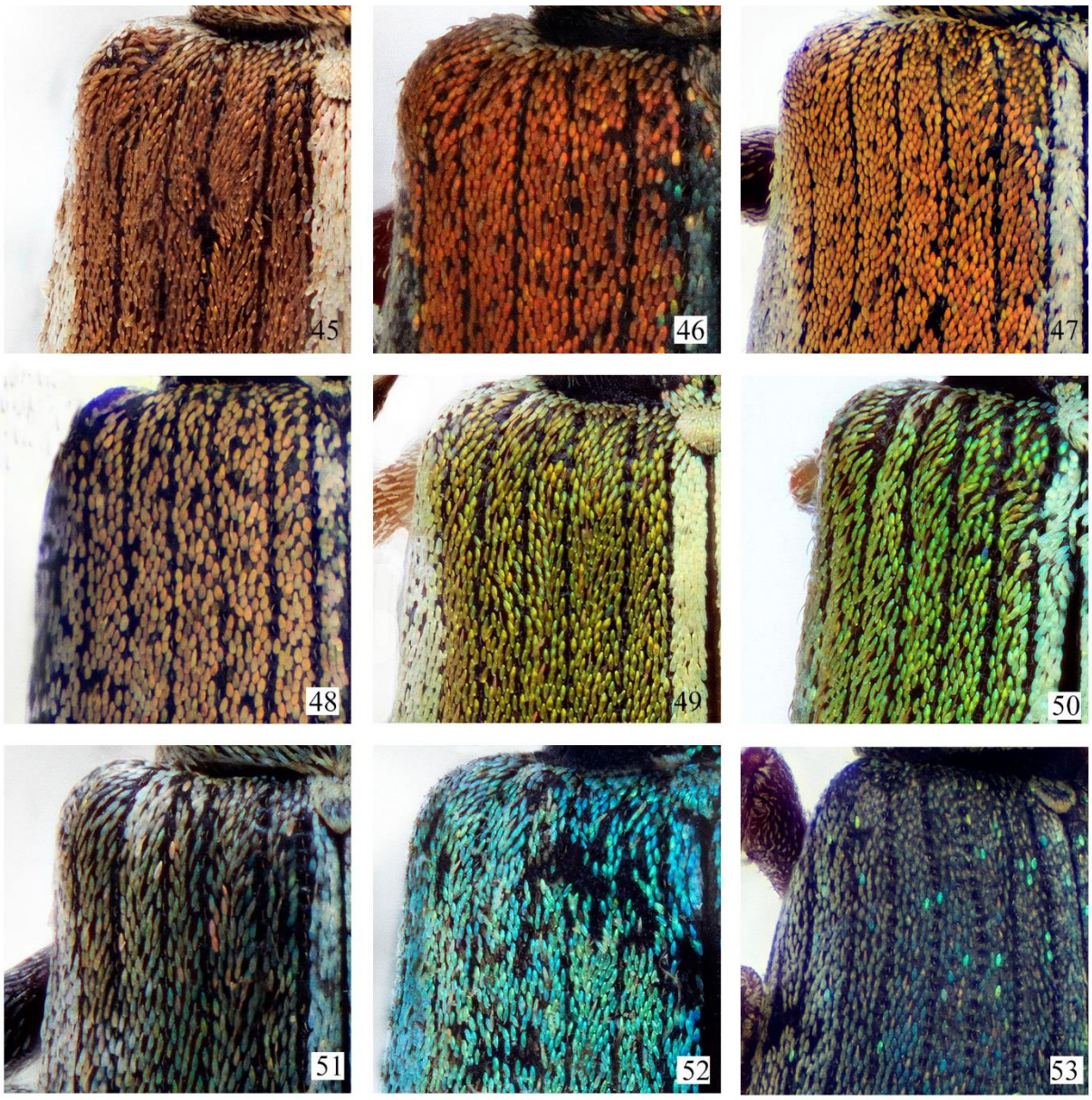
Figures 29-32. 29. *Pachyrhinus elegans* protibia (female) (CSUC). 30. *P. elegans* abdominal sternites (female) (CSUC). 31. *P. elegans* eighth sternite (CSUC). 32. *P. elegans* ovipositor (CSUC).



Figures 33-38. *Pachyrhinus elegans*, female, (USNM). 33. Dorsal view. 34. Lateral view. 35. Ventral view. 36. Frontal view. 37. Elytral scales. 38. Label.



Figures 39-44. 39. *Pachyrhinus elegans* left elytron, dorsal view (CSUC). 40. *P. elegans* stria and interstria (CSUC). 41. *P. elegans* aedeagus, lateral view (CSUC). 42. Aedeagus, ventral view. 43. Aedeagus, dorsal view. 44. *P. elegans* Spermatheca (CSUC).



Figures 45-53. *Pachyrhinus elegans* elytral scales. 45. Larimer Co., Colorado (USNM). 46. Boise Co., Idaho (USNM) 47. Boise Co., Idaho (USNM). 48. Boise Co., Idaho (USNM). 49. Larimer Co., Colorado (USNM). 50. Cumberland Co., Maine (USNM). 51. Lake Co., Montana (USNM). 52. Clear Creek Co., Colorado (USNM). 53. Latah Co., Idaho (USNM).

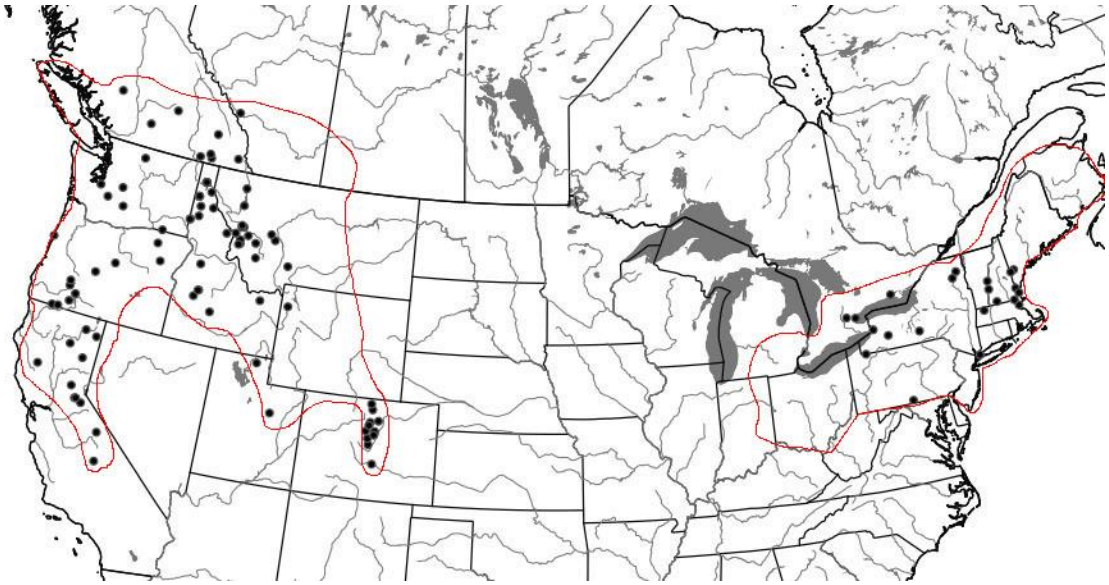
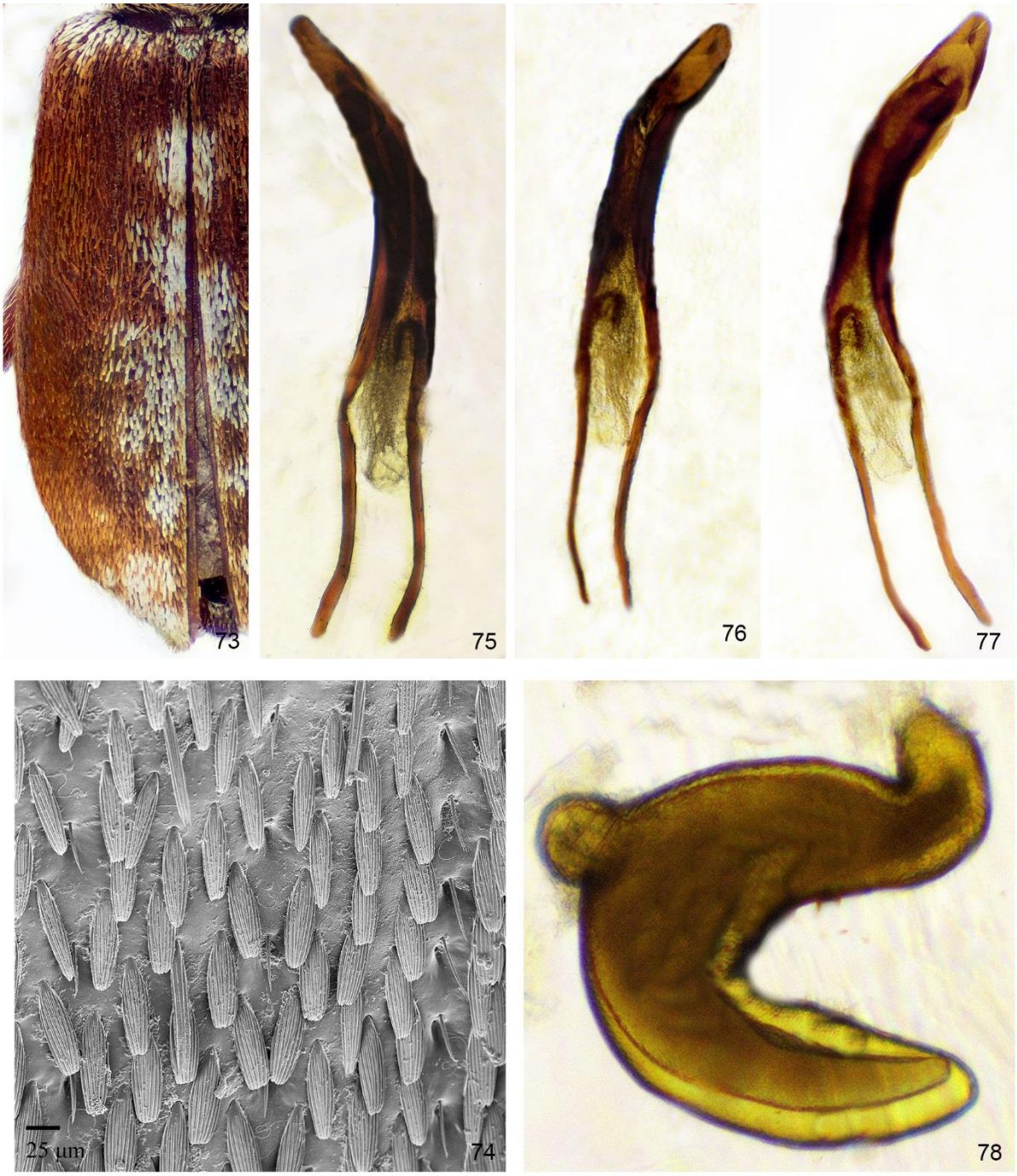


Figure 54. *Pachyrhinus elegans.* Black circles are examined specimens. Red outline delimits known range.

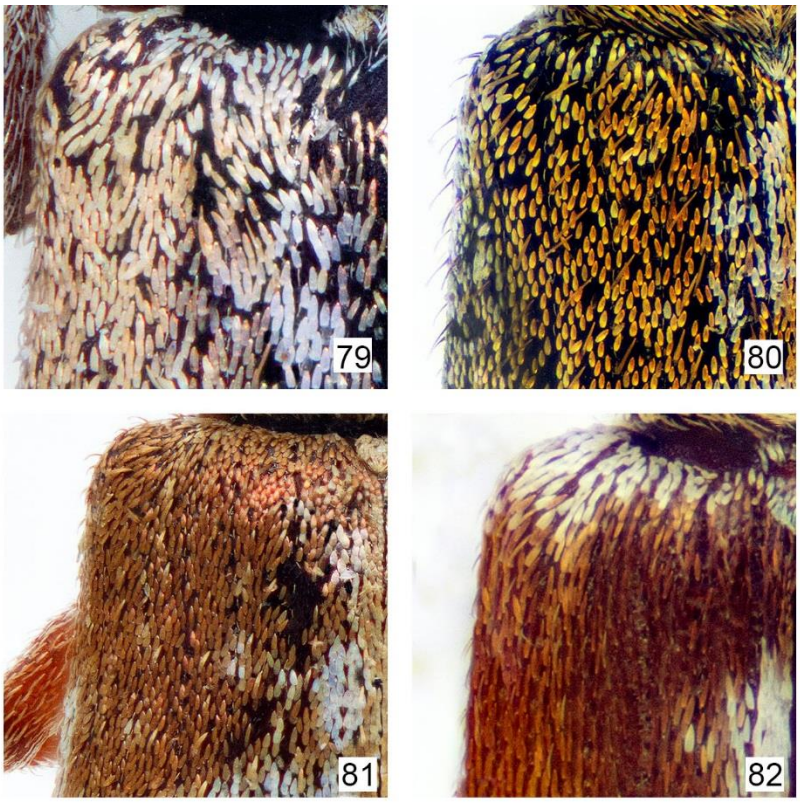
Figure 55-60. *Pachyrhinus lateralis*, holotype, male, (USNM). 55. Dorsal view. 56. Lateral view. 57. Ventral view. 58. Damage to prothorax, lateral view. 59. Elytral scales. 60. Labels.

Figure 61-66. *Pachyrhinus miscix*, holotype, male, (MCZC). 61. Dorsal view. 62. Lateral view. 63. Ventral view. 64. Frontal view. 65. Elytral scales. 66. Labels.

Figures 67-72. *Pachyrhinus californicus* holotype, female, (MCZC). 67. Dorsal view. 68. Lateral view. 69. Ventral view. 70. Frontal view. 71. Elytral scales. 72. Labels.



Figures 73-78. 73. *Pachyrhinus californicus* left elytron, (USNM). 74. *P. californicus* stria (CSUC) 75. *P. californicus* aedeagus, lateral view (CSUC). 76. Dorsal view. 77. Ventral view. 78. *P. californicus* spermatheca.



Figures 79-82. *Pachyrhinus californicus* scale variation. 79. Stanislaus Co., California. (EMEC) 80. Mendocino Co., California. (USNM). 81. Monterey Co., California. (USNM) 82. Marin Co., California. (USNM).

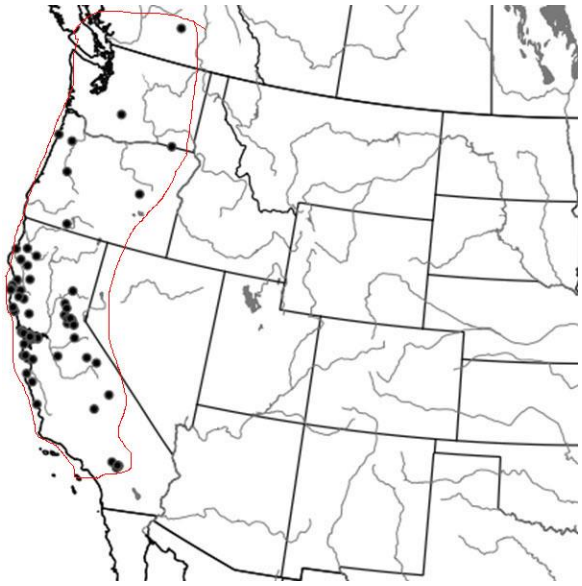
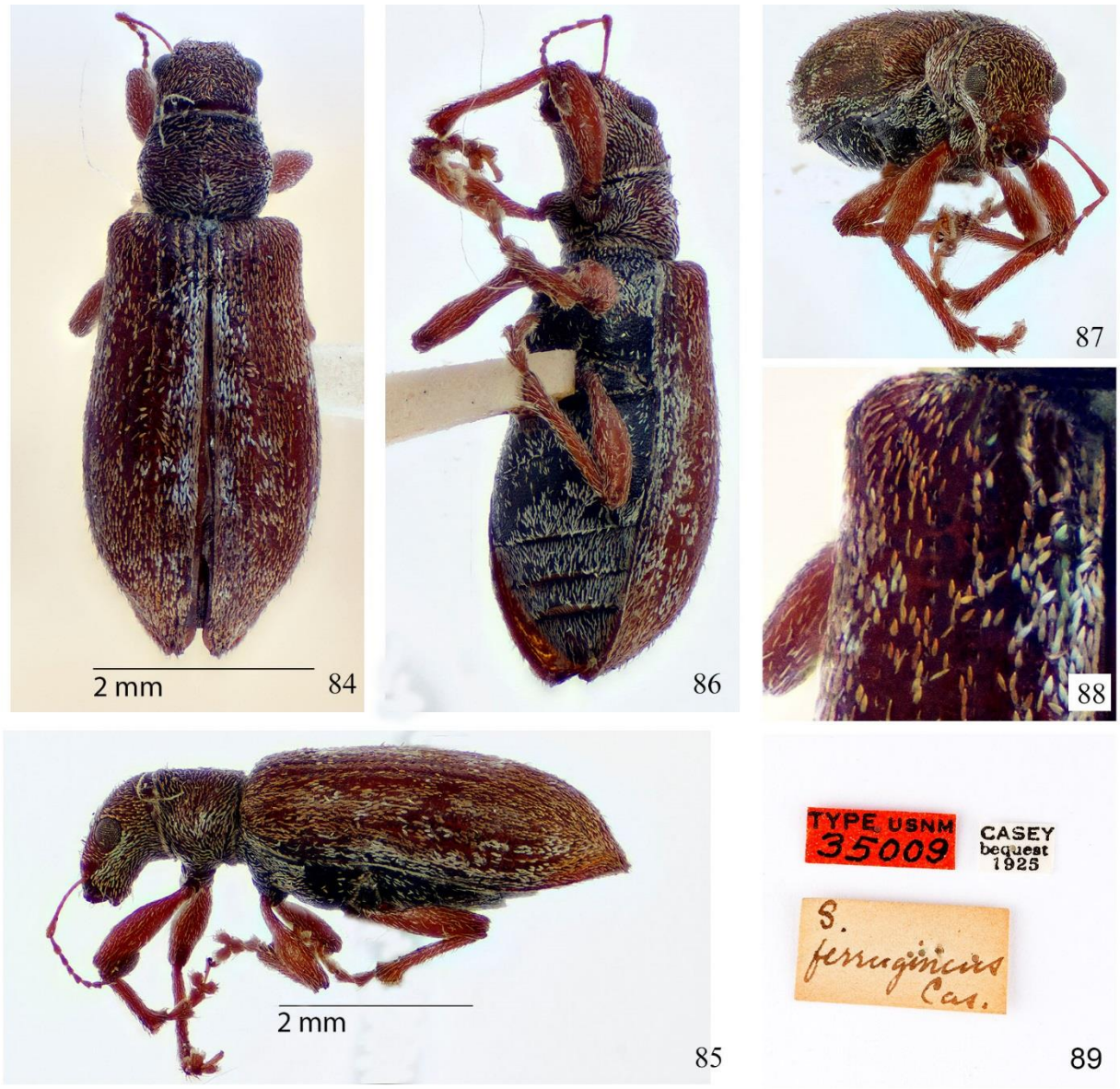


Figure 83. *P. californicus.* Black circles show examined specimens. Red outline delimits known range from literature.



Figures 84-89. *Pachyrhinus ferrugineus*, holotype, female, (USNM). 84. Dorsal view. 85. Lateral view. 86. Ventral view. 87. Frontal view. 88. Elytral scales. 89. Labels.

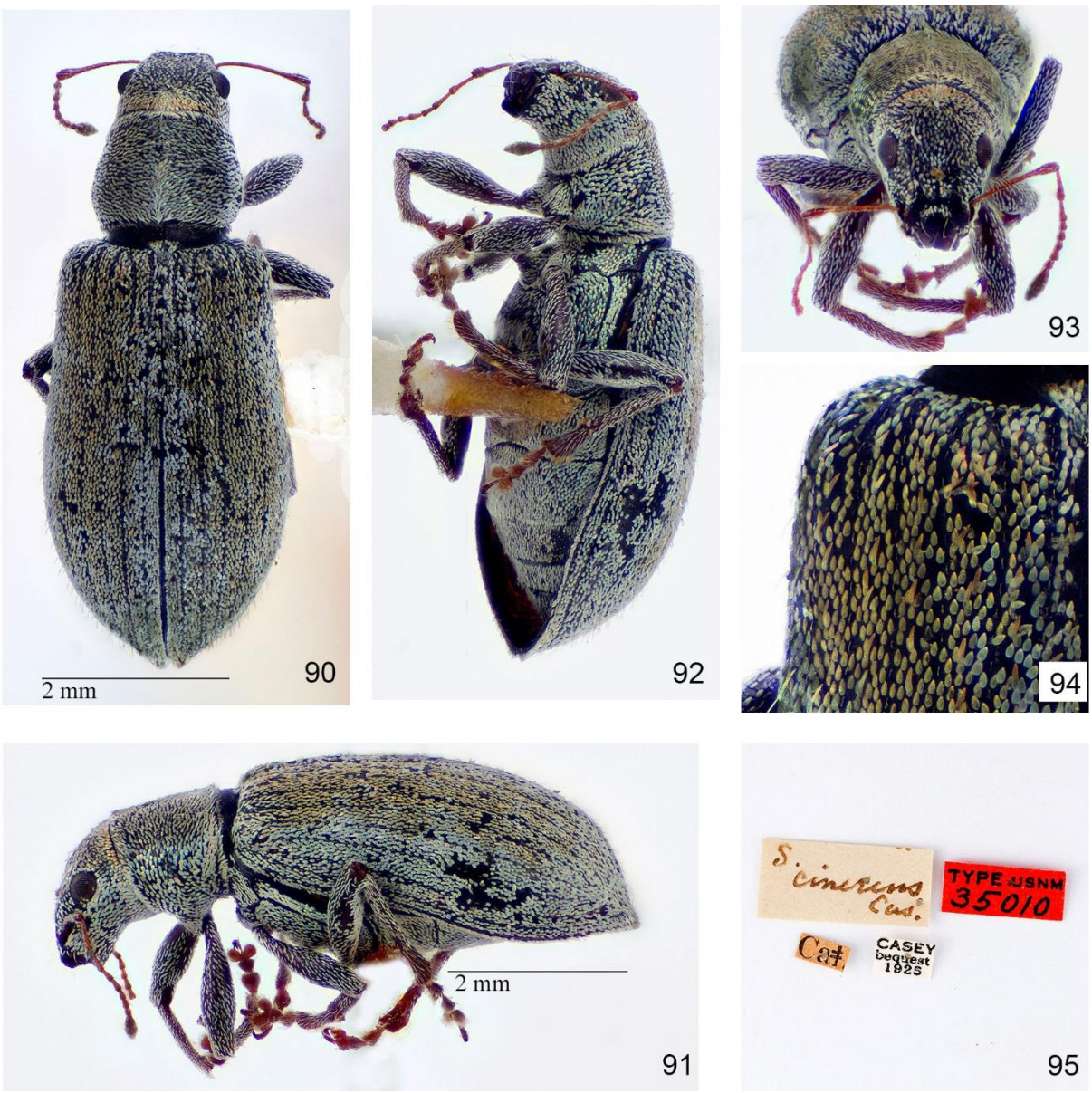
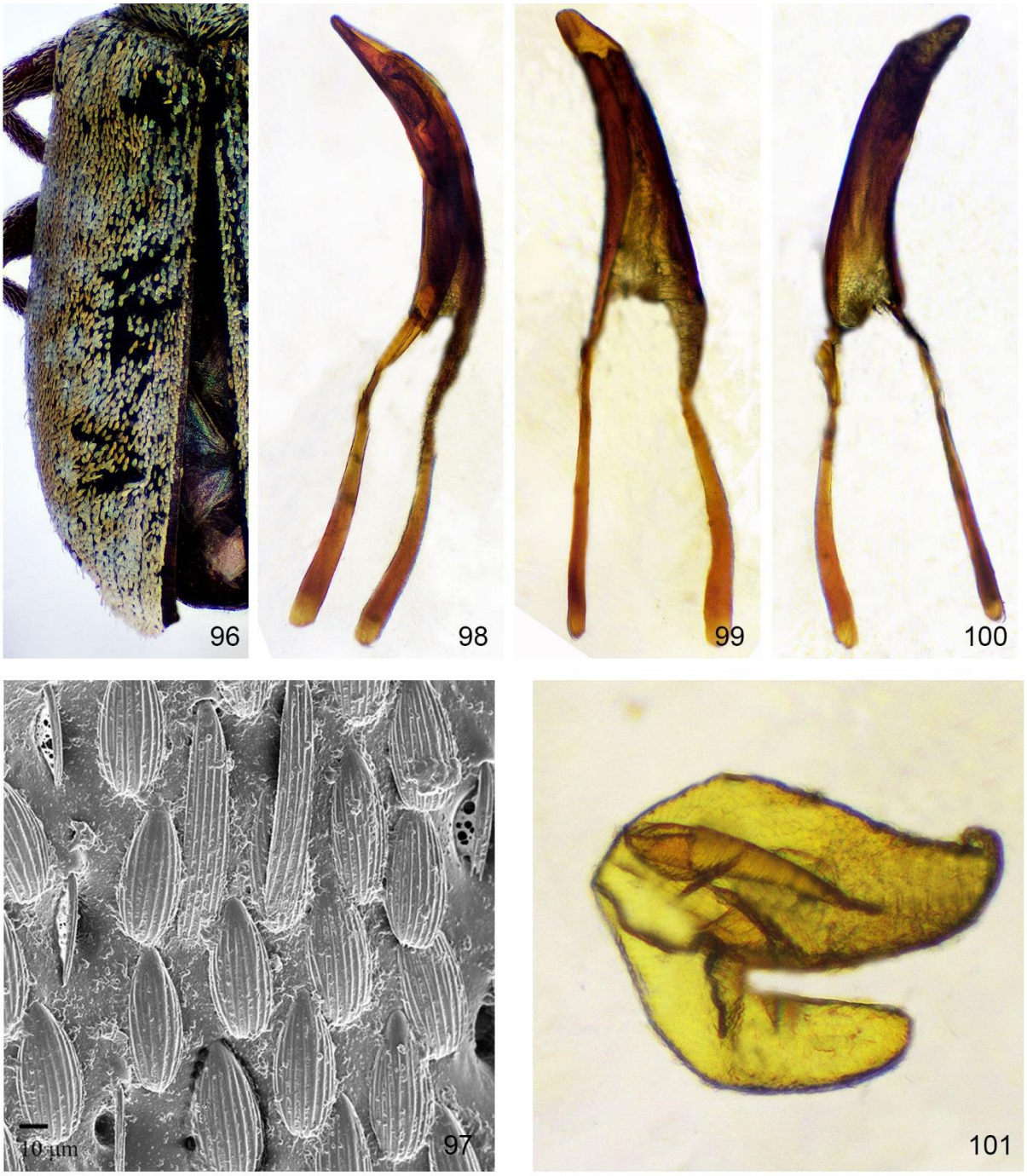
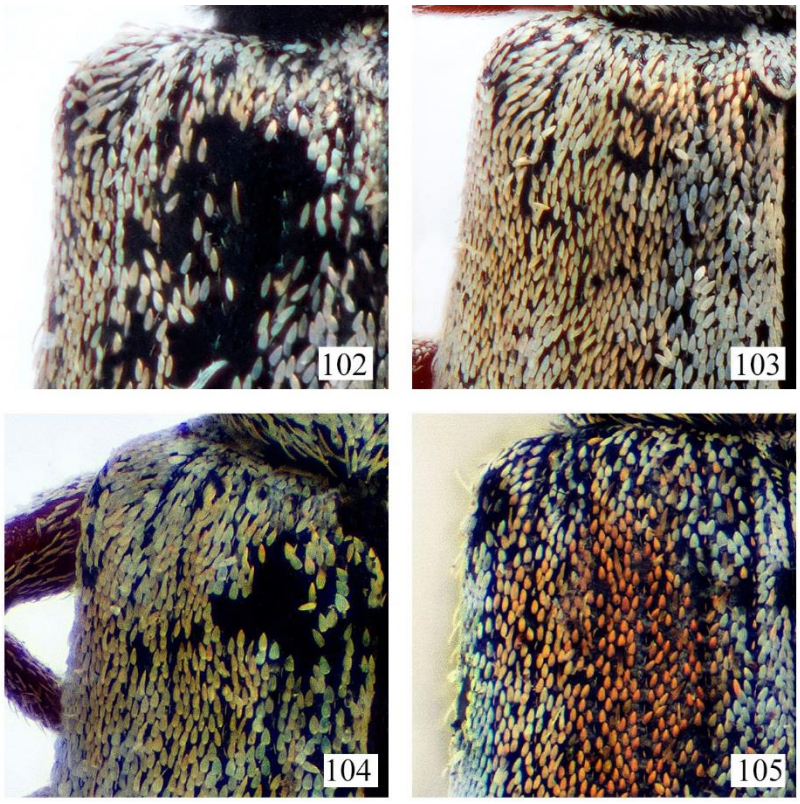


Figure 90-95. Habitus photos of female *Pachyrhinus cinereus*, holotype, female, (USNM). 90. Dorsal view. 91. Lateral view. 92. Ventral view. 93. Frontal view. 94. Elytral scales. 95. Labels.



Figures 96-101. 96. *Pachyrhinus cinereus* left elytron (USNM). 97. *P. cinereus* stria (CSUC). 98. *P. cinereus* aedeagus lateral view (CSUC). 99. Aedeagus ventral view. 100. Aedeagus dorsal view. 101. *P. cinereus* spermatheca (CSUC).



Figures 102-105. *Pachyrhinus cinereus* elytral scales. 102. Monterey Co., California (EMEC). 103. Monterey Co., California (EMEC). 104: Ravalli Co., Montana (USNM). 105: El Dorado Co., California (USNM).

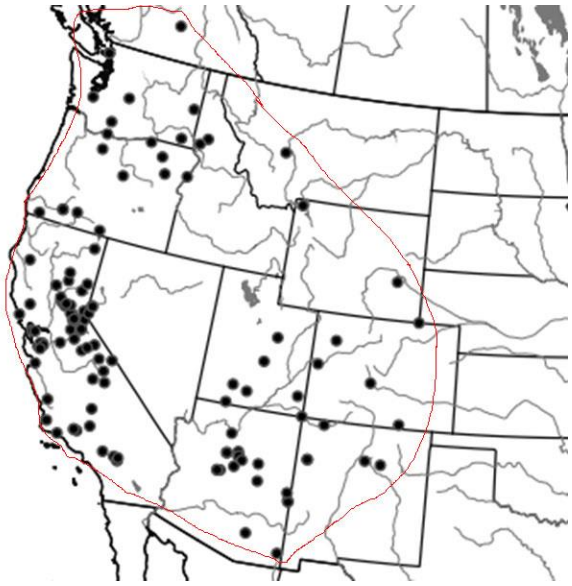
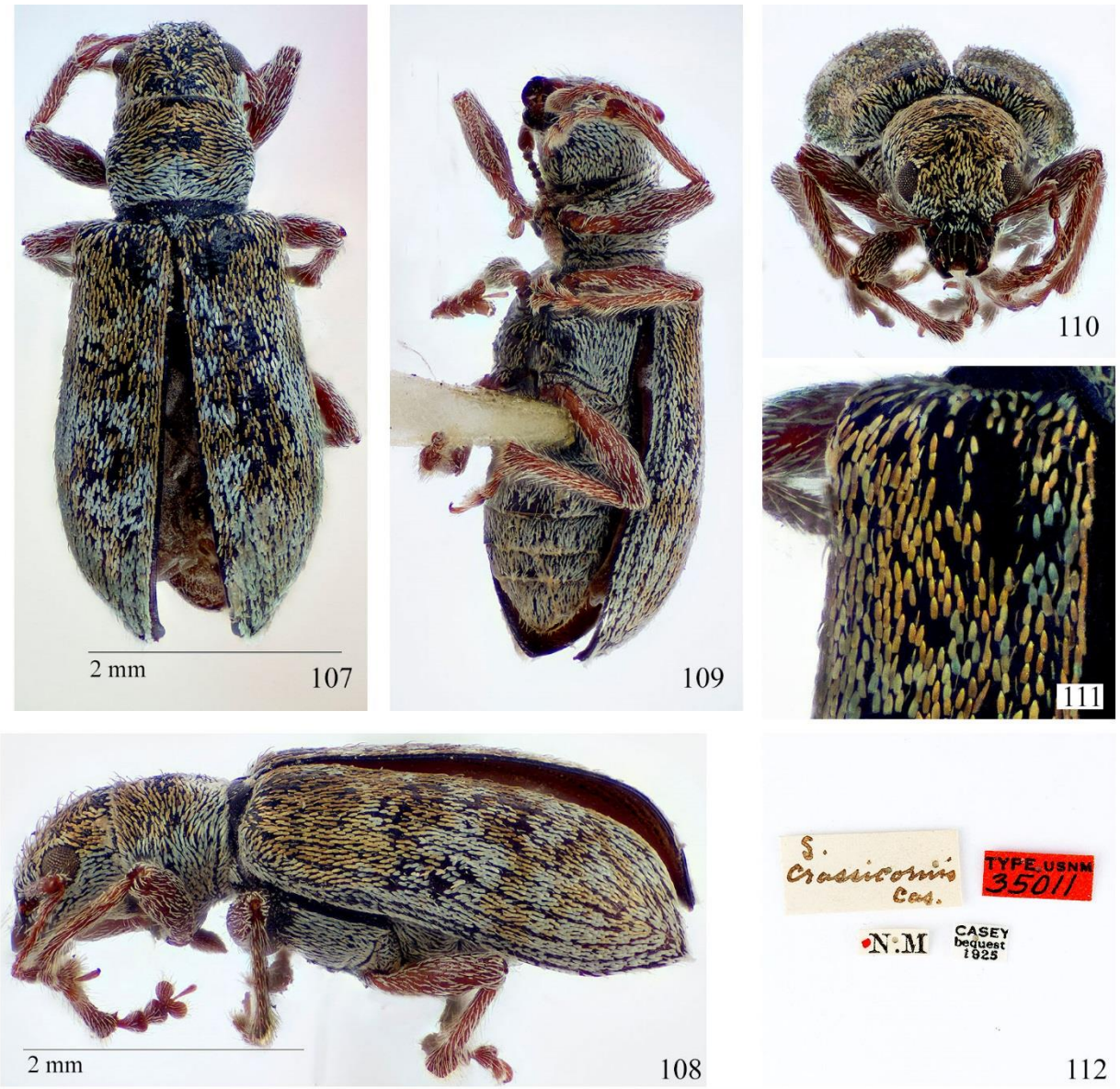


Figure 106. *Pachyrhinus cinereus.* Black circles are examined specimens. Red outline delimits known range from literature.



Figures 107-112. *Pachyrhinus crassicornis*, holotype, male, (USNM). 107. Dorsal view. 108. Lateral view. 109. Ventral view. 110. Frontal view. 111. Elytral scales. 112. Labels.

Figures 113-118: *Pachyrhinus albidus*, holotype, female, (MCZC). 113. Dorsal view. 114. Lateral view. 115. Ventral view. 116. Frontal view. 117. Elytral scales. 118. Labels.

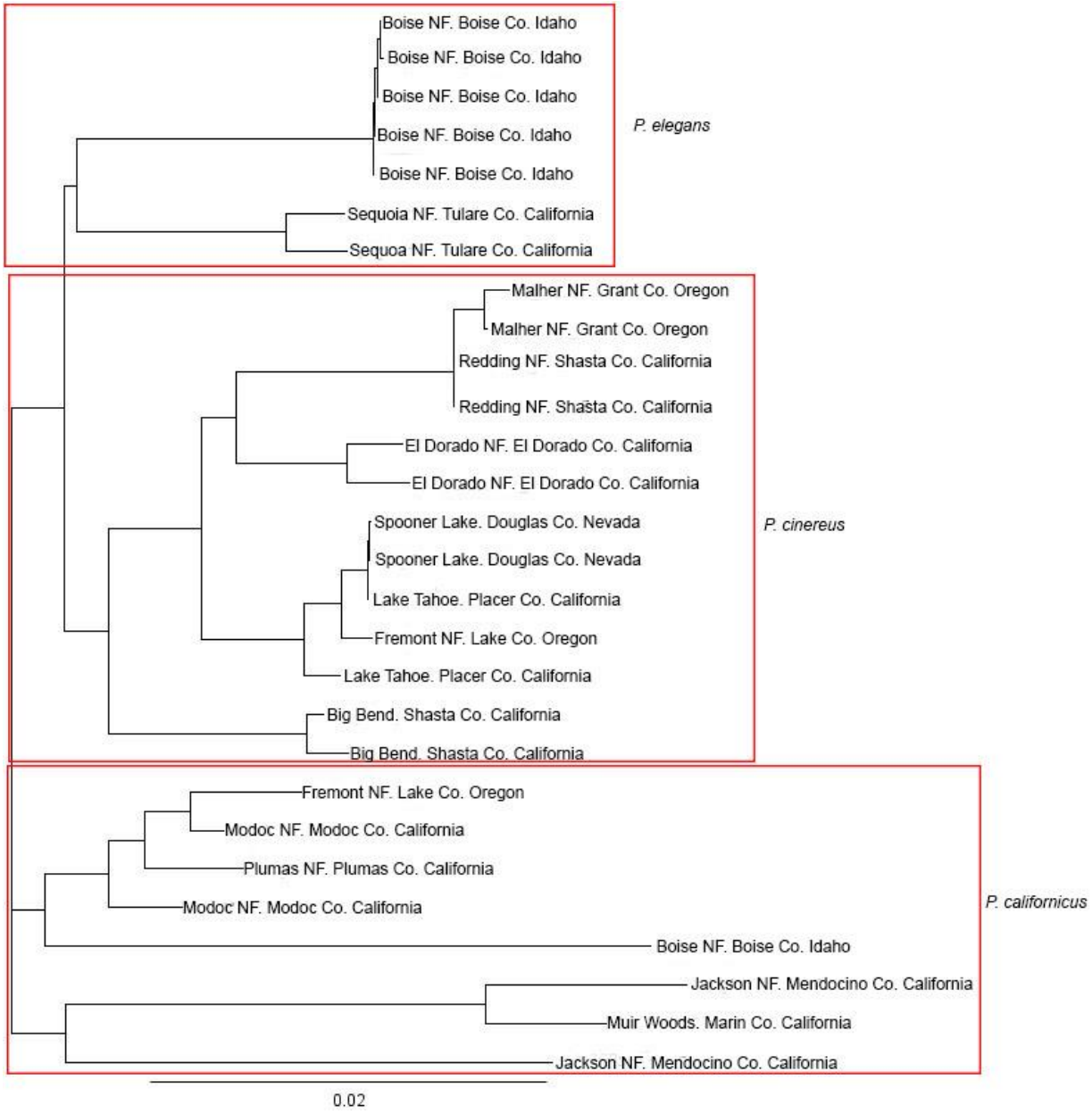


Figure 119: Neighbor joining tree of the COII sequence data from 29 individuals collected in California, Idaho, and Oregon.

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